

NOTES

ON

AMMUNITION.

FOURTH EDITION,

CORRECTED UP TO JULY 1877.



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PREFACE TO ORIGINAL EDITION.

This book has been mainly compiled from "Treatise on Ammunition," Parts I. and II. It is intended for the use of Non-commissioned Officers and Men who are unable to provide themselves with the larger works, and it is hoped that it may also be useful to Officers. The information contained in Parts I. and II. will, however, still be necessary for those who require a thorough knowledge of stores. A new treatise on ammunition is now in the press. Detailed information will be found in the Changes of War Stores, to which reference is given.

I have received much assistance from Sergeant-Major Macken, R.A., in preparing this work for the press. The following very important circulars are given in the Appendix :—

Regulations for gunpowder magazines.

Regulations to be observed in making up cartridges, filling shells, and examining ammunition in laboratories in Artillery charge.

Regulations to be observed in the employment of lamps for lighting magazines.

Revised instructions for the proof of tubes, primers, fuzes, &c.

W. R. BARLOW,

Major, R.A.,

Cap. Instr. R.L.D.

PREFACE TO FOURTH EDITION.

A new edition of these notes having been called for, it has been found necessary to make various alterations, owing to the changes which have taken place in *matériel* since the issue of the last edition in 1874.

The general plan of the book remains unaltered; a few portions have been, however, slightly rearranged, and a small amount of new matter added, while the necessary corrections up to date have been made.

J. P. C.

Royal Laboratory,
May 1877.

LIST OF ABBREVIATIONS.

F.G.	Fine Grain.
R.F.G.	Rifle Fine Grain.
R.F.G ² .	" " " for Martini-Henry rifles.
L.G.	Large Grain.
R.L.G.	Rifle Large Grain.
P.	Pebble.
P ² .	Cubical 1½".
L.S.	Land Service.
S.S.	Sea Service.
G.S.	General Service.
F.S.	Field Service.
R.L.	Royal Laboratory.
R.G.F.	Royal Gun Factory.
R.C.D.	Royal Carriage Department.
S.B.	Smooth Bore.
M.L.	Muzzle Loading.
B.L.	Breech Loading.
M.L.O.	Muzzle Loading Ordnance.
R.M.L.O.	Rifled Muzzle Loading Ordnance.
R.B.L.O.	Rifled Breech Loading Ordnance.
S.A.	Small Arms.
R.A.	Royal Artillery.
§	Paragraph of Changes in War Stores.
A.C.	Army Circular.
Extracts.	Extracts from proceedings of Director of Artillery.

§ 914.

NOTE.—Stores which are issued for practice only are to be marked with a yellow line. A blue line is painted on obsolete stores in the Royal Laboratory, while red is often used to indicate powder. The colour red is generally used as an indication of danger; thus, a red flag is used at rifle ranges, powder barges, &c. are painted red, and filled shells are marked with red letters. This colour is also used in the electric detonators, &c., when they contain fulminate of mercury. In demanding stores it is necessary to name them in the same manner as in the priced Vocabulary, but in this work the ordinary name is generally made use of. Thus the large mortar fuze would be strictly designated as "fuze, time, wood, Boxer, mortar, large." The nomenclature of the priced Vocabulary is adhered to in the index.

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NOTES ON AMMUNITION.

CHAPTER I.—GUNPOWDER, GUN COTTON, AND INGREDIENTS USED IN COMBUSTIBLE COMPOSITIONS.

CLASSIFICATION.—VARIOUS KINDS OF POWDER USED IN THE SERVICE.

—USE TO WHICH EACH KIND IS PUT IN THE ROYAL LABORATORY.

—MONOGRAMS OF STATIONS.—GUN COTTON.—VARIOUS INGREDIENTS USED IN COMBUSTIBLE COMPOSITIONS.

GUNPOWDER has, in 100 parts, saltpetre, 75 ; charcoal, 15 ; and sulphur, 10. Its action depends not only on its composition, but on the size and form of the grain, its density,* and many other details which cannot be embraced in this course. It explodes when heated to about 600° F.

The smaller the grain of the powder in a given charge, the larger is the surface offered to combustion. If, therefore, the flame could reach each grain, we should find that the smaller they were, the more rapid would be the combustion ; but when very small, the grains pack so tightly together that the flame cannot pass quickly between them ; and hence it is found that, for two different reasons, very small grained mealed powder and very large powder are both slow burning. Between these extremes will be found the varying sizes of grains suitable for the various natures of ordnance and small arms, and for the bursting charge of shells.

The regularity and rate of burning depends much on the density. The denser the powder the slower will be its rate of burning. Moreover, powder made from charcoal burnt rapidly at a high temperature burns slower than powder made from charcoal burnt a longer time at a low temperature ; this latter is much softer than the former, and has a more or less brown colour.

* Density refers to the weight of any given portion of a substance compared with the weight of an *equal volume* of distilled water. For instance, when we say that the density of P. powder is 1·8, we mean that any given volume of it will weigh just 1·8 times as much as an equal volume of water. A cubic foot of water weighs, approximately, 1,000 oz. ; so that a cubic foot of P. powder, supposing it to be in one solid mass without any interstices between the grains, will weigh 1,800 oz.

Although not absolutely true, it may be taken as a general rule, that the larger the grain of the powder, the less violent will be its action; in other words, its combustion will be more gradual. Thus for rifled guns the powder has a larger grain than for smooth bores, as a more gradual action is required to avoid unduly straining the gun.

The size of the grains of powder is determined by the sieve through which it passes. The sieves are distinguished according to the number of divisions in a linear inch, thus a 4-mesh sieve has 16 holes in the square inch, an 8-mesh has 64, and so on. P. and P². powders, being cut into cubes, are distinguished by the length of the edge of the cube.

Mealed powder is ordinary powder reduced to dust by placing it in a revolving barrel with gun-metal balls. The charcoal employed in making the gunpowder is charred in iron cylinders. Mealed powder is used in Laboratory compositions, where great regularity of burning is not required, such as portfires, &c.

Mealed pit-powder differs from the above in the gunpowder being manufactured from charcoal prepared by burning in pits, the charring is not carried so far, and hence a more rapidly burning powder is obtained; it is also found to be more regular in its action, and it is therefore used for fuze composition.

§ 2087.

Although L.G. powder is now largely used with rifle guns, cartridges may be found made up with R.L.G. powder for these guns.* The cartridges made up with L.G. are marked with the letters L.G. in red to distinguish them. The R.L.G. is to be resorted to when the stock of L.G. is used up. S.B. cartridges filled with R.L.G. are to be marked R.L.G. in red.

§ 1998

The following table gives the *serviceable* classes of powder. It is to be noted that the term "service" is to be applied only to powder used for firing projectiles.

Class.	Designation.	Description.
I.	Service - -	1. All new powder. 2. All returned powder (including cannon cartridges) which on examination may be found uninjured.
II.	Blank - -	1. Powder from broken-up cannon cartridges, unless specially placed in Class I. 2. Powder from broken-up S.A. Ammunition (M.L. only.) 3. Service powder found dusty or broken in the grain at periodical inspections, or on return; except such as, being only dusty, is firm enough in grain to be redusted for service.
III.	Shell - -	Powder found too dusty and broken in grain for Class II.

The following list shows the purposes for which powders of the several descriptions are to be used; and demands and issues will be regulated in accordance therewith:

* See next page for the cartridges in which these two powders are to be used; also tables of filled cannon cartridges at end of book.

*P*². For battering charge of 12"·5 R.M.L. gun.* § 3066.

P. For the *battering* charges of all rifled guns of 7-inch calibre and upwards, and for all service charges of 40 lb. and upwards. When no *P*. powder is available, *R.L.G.* will be used.†

Service R.L.G. For service charges to the Royal Navy of 9, 8, and 7 inch R.M.L. guns; also for battering charges of certain guns when *P*. powder is not available,† and for R.M.L. field artillery, *i.e.* for 9, 16, and 25 pr. guns.

Service L.G. For all service charges with R.M.L. land service garrison guns under 10-inch, and S.B. ordnance; for R.M.L. sea service, 80-prs. and under, and R.B.L. guns. The 7-pr. R.M.L. gun, however, is an exception, for which F.G. or R.F.G. is used for land and sea service.

Service R. F. G. For rifled small-arms of every description except Martini-Henry rifle and pistols, for 7-pr. R.M.L. guns, and for the bursting charges of shrapnel shells when the stock of F.G. is exhausted.

*Service R.F.G*². For Martini-Henry rifle.‡

§§ 2487, 3065.

Service F.G. For 7-pr. R.M.L. guns, for all smooth-bore small-arms and for the bursting charges of shrapnel shells.

Service Pistol. For Colt's and Adams' cartridges, and for bursting charges of shrapnel shells made, like F.G. powder, with common (Wills and Alder) charcoal; very little of this pistol powder remains.

Blank, or Exercise, R.L.G. and L.G. For blank charges (including the reduced charges of 9, 8, and 7 inch R.M.L. guns when issued to the Royal Navy) of all descriptions of rifled and smooth-bored ordnance.

*Blank, or Exercise, R.F.G., R.F.G*², and *F.G.* For blank small-arm cartridges of every description. These powders may, if it be considered advisable, be used for blank charges for ordnance when there is a surplus store.

Shell Powder. L.G. for the bursting charges of all shells, rifle, or smooth-bore, except shrapnel (see above), and 6, 9, 12, and 20 pr. segment shells, for which F.G. is to be used, or R.F.G. when the stock of F.G. is exhausted. F.G. or L.G. in Class II. may be taken if no F.G. or L.G. in Class III. be available, and Service F.G. or L.G. if no blank F.G. or L.G. be available.

Service powder will never be issued for *blank* or *exercise* cartridges, when any powder classed under the latter head is available. This rule is intended to apply strictly to the non-issue of Service R.L.G., R.F.G., and R.F.G². powders for blank charges. Exercise powder will not be issued for filling shells when shell powder is available.

* *P*². will probably be used for the 80-ton gun when the latter comes into the service.

† § 2838 gives alternative charges of R.L.G. for the battering charges of R.M.L. guns up to 12" of 25 tons inclusive, and for the full charges, up to that for 12" gun of 35 tons inclusive. Army Equipment, 1876, p. 61, states that R.L.G. is to be used for alternative battering charges of 7, 8, and 9 inch R.M.L. guns only.

‡ The siftings of R.F.G². powder answer well in the cartridges for Adams' B.L. pistol, and the use of them is approved.

Monograms of Stations.

§§ 1633, 2294. To enable the place where cartridges, shells, &c. are filled to be traced, each station where there is a Laboratory, &c. has a monogram. The list of stations and monograms is given below.

HOME STATIONS.

ALDERNEY - - -	A.	GOSPORT - - -	G.
CHATHAM - - -	C.	HARWICH - - -	H.
CHESTER - - -	H C.	GUERNSEY - - -	G .
CORK - - -	S C.	JERSEY - - -	J.
DEVONPORT - - -	D.	PEMBROKE - - -	P.
DOVER - - -	V D.	SHEERNESS - - -	S.
DUBLIN - - -	S D.	TYNEMOUTH - - -	T.
EDINBURGH - - -	E.	UPNOR - - -	U.
FORT GEORGE - - -	E .	WOOLWICH - - -	W.

FOREIGN STATIONS.

BARBADOES - - -	B.	HALIFAX - - -	H.
BERMUDA - - -	B.	HONG KONG - - -	H.K.
CAPE TOWN - - -	C .	MALTA - - -	M.
CEYLON - - -	C .	MAURITIUS - - -	M .
GIBRALTAR - - -	GIB.		

GUN COTTON.

Gun cotton is prepared from ordinary cotton as follows:—The cotton is thoroughly cleansed from all grease, oil, &c., and foreign matters. It is placed for a short time in a mixture of one part by weight of the strongest nitric acid, and three parts by weight of concentrated sulphuric acid. The cotton (now become gun cotton) is freed from the acids by wringing and long washing, and converted into a pulp. This pulp is pressed by hydraulic power into discs or slabs of the required size.

§ 2820.

§ 3056.

Gun cotton is issued in the form of discs, slabs, and primers. It possesses the valuable property of being quite uninjured by water, and thus can be kept damp and dried as required. Wet gun cotton cannot be ignited by any ordinary means, but if a small quantity of *dry* gun cotton is placed in contact with it and “detonated,” the whole mass

will explode as if the cotton were all dry. Wet gun cotton can be exploded without the use of the dry cotton to start the action, but a larger quantity of fulminate is required and the result is not so certain.

Gun cotton will be largely used in mining operations, with torpedoes or submarine mines, and generally for removing obstructions, such as gates, palisades, walls, &c.

When gun cotton is ignited in the ordinary manner, by the application of flame, its action depends on the degree of confinement to which it is subjected; thus if it is loose or only lightly confined in a wooden box it generally burns on ignition without exploding; if, however, it is strongly confined, as in a shell, a very violent explosive action is developed.

When gun cotton is ignited by the action of fulminate of mercury a most violent detonating action is set up, even when the gun cotton is completely unconfined, this is most important as it does away with the necessity of tamping in mines, enables a most destructive action to be obtained from torpedoes where the cotton is enclosed in only a light case, and affords a ready method of beating down walls or bridges, and also answers for cutting away stockades or any similar obstruction.

The fulminate of mercury may be ignited in any convenient manner, either by electricity or by a piece of Bickford's fuze; tin tubes containing 20 grains of fulminate are prepared in the Royal Laboratory Department, but on an emergency the fulminate might be placed in a quill tube, in this case a few more grains of fulminate might be used. The tube is inserted in one of the gun cotton discs in which perforations are made to fit the tube containing the fulminate. A box-wood "rectifier" is issued for use in case the tube of the detonator does not fit fairly easily into the perforation in the disc or slab. It is *most dangerous* to force a detonator in. Care must be taken when using a quill tube not to allow the quick-match leader to touch the gun cotton, as if it did it would ignite it, and the detonating action would not take place.

When detonated by fulminate of mercury the action of gun cotton is about four times as powerful as that of an equal weight of gunpowder, and also more destructive and more local; thus in destroying walls the fragments are not projected to so great a distance, the work being done in shattering and destroying the cohesion of the wall; for destroying stockades, &c. it is only necessary to attach the discs loosely to the wood. Gun cotton ignites at a lower temperature than gunpowder, viz., at about 343° F., and is now used as extra priming for fuzes when firing with small charges (*see* p. 12).

It is issued in wood cases holding 28 lbs. or 50 lbs. for transit.*

Issue.

INGREDIENTS USED IN COMBUSTIBLE COMPOSITIONS IN THE ROYAL LABORATORY DEPARTMENT.

The combustible compositions may be divided into two classes, those which detonate and those which do not; as an aid to memory it may be remarked that chlorate of potash will be found in the detonating class, and saltpetre in the compositions which do not detonate.

* It is to be stored in bulk in tanks containing about one ton of damp cotton. § 2402. The cotton should contain about 20 per cent. water. For details, *see* A.C. 11/76.

- Saltpetre.** *Saltpetre* is used as a source of oxygen, one cubic inch of saltpetre contains as much oxygen as 3,000 cubic inches of air, and as most of the laboratory compositions burn in a confined space it is absolutely necessary to supply them with oxygen; thus saltpetre is found in all our burning compositions which do not detonate.
- Chlorate of potash.** *Chlorate of potash* is also used as a source of oxygen, its use in the laboratory is owing to the property it has of detonating on being rubbed or struck when mixed with sulphur or sulphide of antimony. It is also used with fulminating mercury. It is generally found in detonating compositions.
- Sulphur.** *Sulphur* burns at a low temperature and gives out great heat. It is useful in enabling other ingredients to kindle and burn. Sulphur will be found in all the burning compositions, and in the greater part of detonating compositions, owing to its property of detonating with chlorate of potash.
- Sulphide of antimony.** *Sulphide of antimony*, known also as "crude antimony," possesses the property of detonating with chlorate of potash, and may sometimes replace sulphur. It has moreover the property of burning with a long flame or flash, which renders it useful in compositions intended to ignite other bodies at a little distance; thus it is used in caps, friction tubes, and carcasses.
- Fulminate of mercury.** *Fulminate of mercury* is a most dangerous ingredient to handle, and should never be dealt with by inexperienced men. It detonates readily on being struck, and is used in such compositions as caps and B.L. fuze detonators. In the Royal Laboratory it is kept wet till required for use.
- Red orpiment.** *Red orpiment* is a bi-sulphide of arsenic, and gives a bright white flame in burning, which is useful in light compositions.
- Magnesium.** *Magnesium* has a more brilliant white flame, and will probably be extensively used in light compositions.
- Spirits of turpentine.** *Turpentine* dissolves rosin in carcasses, it makes a kind of cement, binding the mass together.
- Methylated spirit.** *Methylated spirit* is spirit of wine to which methyl has been added to render it undrinkable, it is used for damping detonating compositions, so as to make them into a paste to enable them to be handled; it evaporates without injuring the composition.
- Charcoal.** *Charcoal*.—We may say roughly that charcoal acts the part of fuel, which combines with the oxygen of the saltpetre, enabling it to burn, and in combining with it forms an expansive gas. It is used in rocket composition and gunpowder.
- Mealed powder.** *Mealed powder* causes compositions to burn readily and quickly, and the rate of burning may to some extent be regulated by the quantity of mealed powder employed.

CHAPTER II.—GAUGES OF SHELLS BOTH S.B. AND RIFLED. FUZES, TIME AND PERCUSSION.

FUZE HOLE GAUGES of all SHELL and the FUZES which fit each GAUGE.

Gauge.	Shell.	Fuze.
Large mortar	- Large mortar, 13", 10", 8" -	Large mortar time.
Common	- S.B. common and diaphragm shrapnel.	Common, diaphragm, and small mortar time. Pettman's land service percussion.
General service	- S.B. naval shell and all rifled shell except B.L. field service segment and common.†	5, 9, or 20 secs. B.L. or M.L. time.* Royal Laboratory percussion, Marks I. and II., and Pettman's G.S. percussion.
Armstrong field service	B.L. field service, segment and common.	B.L. plain percussion, and, for S.S., Armstrong E. time.

N.B.—This table only shows the gauges of both shell and fuzes, not the fuze which is to be used with each nature of shell. Tables giving the fuze for every shell will be found in the Appendix, p. 119.

All shell having the obsolete Moorsom gauge can be converted to the G.S. gauge by using an adapter. There are two kinds, viz., for spherical and rifle shell respectively; for the latter, Marks I., II., and III., are serviceable in the L.S.; for S.S., Marks II. and III. only. Adapters G.S. §§ 1396, 1427. 1838.

For the 20-pr. common shell in the L.S. a "flanged" socket converts the Moorsom into the F.S. gauge. §§ 1845, 2843.

The following are general rules for the employment of time fuzes for rifled ordnance :—

- 1st. The 5 secs. fuze is for use with shrapnel shell for ranges up to about 1,700 yards with R.M.L. guns, and to about 1,600 yards with B.L. guns.
- 2nd. The 9 secs. fuze is used for shrapnel, common, 7" and 7-pr. double shell, and garrison segment shell. It is available for ranges up to about 2,800 yards with R.B.L. guns, and up to about 3,100 yards with R.M.L. guns.
- 3rd. The 20 secs. fuze is for garrison common shell and for garrison segment shell at long ranges, and for the 7-pr. double shell. It is not available for shrapnel because there are no powder channels to conduct the flame to the primaf.

The time fuzes in the land service at present are all made of wood on General Boxer's pattern, they are all taken from the same cone, though not from the same part. Beech wood is employed for fuzes, as it is hard, tough, and little liable to alter its form : the wood is desiccated before turning.

* Time fuzes will not, in future, be used with common shell fired from M.L. rifled guns above the 80-pr. calibre, except in the case of the 7-in. gun when using 14 lbs. charges (S.S. only). § 2360 and Errata in Changes, Dec. 1872.

† The 20-pr. B.L. common shell for S.S. has the G.S. gauge.

The heads of time fuzes are well protected against accidental ignition. In the case of the fuzes for S.B. ordnance the heads are protected by a thin block tin cap and a disc of pasteboard; in the case of the fuzes for R.M.L. ordnance the quick-match priming and the escape holes are protected by a turn of brown paper, and further by a band of copper between two tape bands. In Mark II. fuzes, however, the tape only, not the copper bands are found. In the case of B.L. fuzes the escape holes are protected by discs of copper and papier mâché. Before firing, the cap or band is to be torn off so as to expose the quick-match priming to the flash of the discharge.

Gun cotton
priming.
§ 2285.

When R.M.L. field guns are fired at high angles with reduced charges it is found that the flash of discharge sometimes fails to ignite the quick-match priming of the time fuzes. In consequence of this, strands of loosely twisted gun cotton are issued, to be wound round the heads of the fuzes, and by this means, on account of the low igniting point of gun cotton and its proneness to ignition, the lighting of the fuze is rendered more certain. The gun cotton for this purpose is issued in small tin cylinders, and each cylinder contains instructions for use.

As shells fired from rifled ordnance fly point first, time fuzes with these shells will generally act as percussion fuzes in the case of direct impact with a moderately solid obstacle. The 20-second fuze, owing to the absence of powder channels, cannot be so well depended on in this respect as the 9-second and 5-second fuzes.

Percussion fuzes may be divided into two classes. (1.) Those which act on graze. (2.) Those which act on direct impact. The B.L. plain and R.L. percussion are the only fuzes which can be depended on to act on graze, and therefore are suitable for use against troops in the open. The Pettman fuzes are not designed to act on graze, though the L.S. fuze may occasionally do so. Neither could wooden time fuzes fired from rifled ordnance be depended on to act on graze.

The Navy still retain the Armstrong E. time fuzes.

Fuze com-
position.

Two kinds of composition are used in time fuze. (1.) Mealed gunpowder, which burns at the rate of one inch in two and a half seconds, employed only in the 5 seconds fuzes, and (2) fuze composition, which consists of—

Ground saltpetre	-	-	-	46·4
Mealed pit powder	-	-	-	39·3
Sublimed sulphur *	-	-	-	14·3
				<hr/> 100·0

and burns at the rate of one inch in five seconds.

In all time fuzes (large and small mortar fuzes, and parachute light fuzes, excepted), the unit marked on the fuze refers to half seconds of time; thus, 4 means that if the fuze be bored at that mark it will burn 4 half seconds or 2 seconds; 5·5 means that it will burn 2½ seconds; by placing a cypher after the figures on mortar fuzes, they also will read half seconds.

The object of using mealed powder in the 5 seconds fuze is to enable the marking to be carried to quarter seconds, as the composition burns twice as quick as fuze composition. As will be seen hereafter, it is very desirable to have small intervals of graduation for fuzes used with field shrapnel shell, for which projectiles these fuzes are chiefly constructed. A length of mealed powder which burns ¼ second is the same as a length of fuze composition which burns ½ second, and thus space is gained for marking.

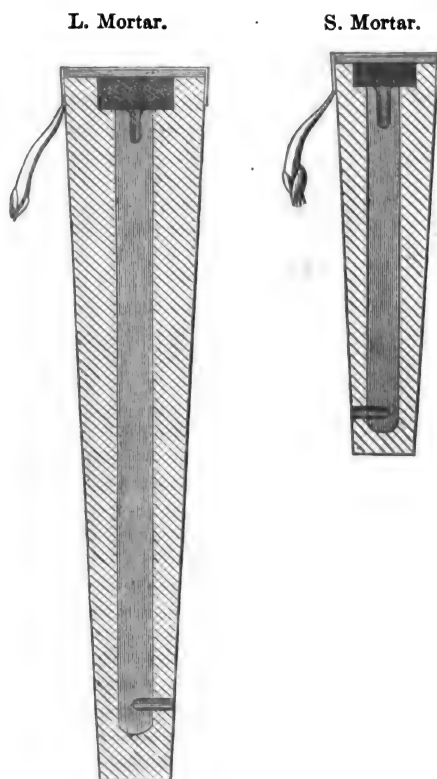
* Ground distilled sulphur to be used in future.

All wood fuzes are painted in black and drab, except the 5 secs. mealed powder fuzes, which are painted in red and drab. Fuzes of recent manufacture are marked with the date, and No. of thousand of manufacture, and a Roman numeral indicating the pattern.

The time fuzes of the G.S. gauge are packed in tin cylinders holding 5 fuzes. The cylinders are secured by a tin strip soldered on; they are well protected from damp by the solder.* Issue of fuzes. § 2217.

Common and diaphragm shrapnel fuzes are to be found still packed in zinc cylinders holding 50 or 25, but in the event of new fuzes being made or old fuzes being repacked at Woolwich, tin cylinders to contain 5 fuzes would be adopted.

The large mortar fuze is used with 8", 10" and 13" mortar shell, its construction is shown by the figure (*see cut*), the head is protected by a tin cap and disc of pasteboard, which is removed by means of the tape when the shell is placed in the mortar. Ignition is secured by means of quick-match priming, and also by the hole in the top of the fuze composition. The composition is driven in a channel bored in the centre of the wooden cone, its length being 6 inches; the fuze burns 30 seconds. The figures on the fuze refer to the inches of composition, but, as before pointed out, by adding a cypher they will refer to the general half second unit; only 5 divisions are marked to the inch, so the fuze reads to seconds. There are no holes bored at the marks on the fuze, but only indentations. The fuze is bored through at 6 inches, (in future manufacture a pellet will be inserted as in the 20 secs. fuzes, p. 16,) so it will act without boring at this length. The first hole marked for boring is at 2". Large mortar fuze.



The first ring on this fuze serves to mark the depth it will enter the fuze hole of 13 and 10" mortar shell, below this, at a distance of 9", another ring marks where the fuze is gripped by 8" shell. The first hole will only act in the 10" shell, as it falls against the metal in the 13" and 8" shells. For preparation, and implements required in preparation, of this fuze, *see* p. 33.

* A buff leather pocket or pouch to hold 5 Boxer fuzes is issued for F.S. It is § 1994. fitted with a strap to fasten round the waist. It also carries a borer. Six cylinders containing thirty 5, 9, and 20 seconds M.L. fuzes are packed in a wood case.

Action.

The fuze is ignited by the flash of the discharge and burns till the flame reaches a bored hole, through which it passes and explodes the shell.

Issue.

Packed in whole size metal-lined case holding 330.

Small mortar fuze.

Small mortar fuze used with 24-pr. and 12-pr. common shell fired from 5½" royal, and 4½" cohorn mortars respectively at long ranges (*see cut*, p. 13). It is of the same gauge as the common fuze, but longer, containing 3 inches of fuze composition burning 15 seconds; its marking and construction are similar to the large mortar fuze; therefore the intervals between the holes correspond to one second of time in burning. The first mark for boring is at 1 inch.

When used with the 12-pr. shell a piece of rag, paper, &c. must be wrapped round the fuze to make it fit.

Issue.

1,000 in metal-lined case, but in future will be issued in tin cylinders holding 5 fuzes.

Diaphragm shrapnel fuze.

Diaphragm fuze, used for diaphragm shrapnel shell. The arrangement for protecting the head, and for the ignition is similar to that

Diam. Shrapnel.



given above. Four holes are bored through the top of the fuze to secure the quick match. The channel for the fuze composition is bored eccentrically so as to give space for two powder channels, one of which is shown in the section (*see cut*). The main channel is driven with fuze composition, the powder channels are filled with pistol powder, and the powder in each channel is supported by a piece of quick match passing through the lowest hole, by means of which the flame explodes the shell if the fuze is not bored. A groove cut in the bottom of the

fuze with a piece of quick match laid in it unites the two powder channels. Holes are bored through into the powder channels, filled with powder and protected by clay being pressed upon them. They are covered externally by varnished paper.

The powder channels are useful, because, (1) in case of the hole bored coming in contact with the metal of the shell, they carry the flash to the charge; (2) by having the odd numbers marked on one channel and the even on the other, they allow smaller divisions to be marked, reading to half seconds; (3) because with Shrapnel shell a powerful flash is necessary to ensure the powder igniting, owing to the construction of the shell.

Common.



The length of fuze composition is one inch, the fuze burns 5 seconds, and it is marked on the side channels up to 10 half seconds.

For preparation, and implements required in preparation, of this fuze, *see* p. 31.

Action.

The flame from the fuze composition ignites the powder in one of the channels at the point where the fuze has been bored, which explodes, giving a strong flash through the bottom holes, and both channels explode together as they are connected by the quick match at bottom.

Common fuze.

Common fuze used with S.B. common shell * (*see cut*). The con-

§ 2097.

* The 5, 10, and 15 seconds fuzes, which were issued specially for the 7-pr. gun, may be used with S.B. common shells, as they are obsolete for the 7-pr., which has now the G.S. gauge. They resemble Mark II. M.L. fuzes, but are of the common gauge.

struction is the same as the diaphragm fuze except that the powder channels are not connected at the bottom by quick match, but are stopped with shellac putty. It contains 2 inches of composition and burns 10 seconds; the preparation and action are identical with the diaphragm fuze. This fuze would be used instead of the small mortar fuze, when 12 and 24 pr. shells are fired at short ranges out of the $4\frac{1}{2}$ and $5\frac{1}{2}$ inch mortars. The common fuze may also be used with 100-pr. diaphragm shrapnel shell.

5 seconds *M.L. fuze* is used for R.M.L. shrapnel shell, G.S. gauge, up to the 80-pr. inclusive; also for 16-pr., 9-pr., and 7-pr. common shell (L.S. only) for short ranges; it contains 2 inches of mealed powder, and burns 5 seconds.*

5 seconds *M.L.*
§§ 1953, 2064,
2485.

The general arrangements resemble those of the common fuze, but the head is closed by a gun-metal plug, round the pin of which quick match is looped and led through two fire holes to a groove.

This arrangement of the head obliges the fuze to be longer than the common fuze.

A paper lining is introduced to prevent the formation of a space between the wood and the composition in the event of the wood shrinking, which would cause the fuze to act prematurely; it also enables the side holes to be made deeper, and so facilitates the preparation of the fuze. In Mark III. fuzes, however, the side holes are not carried beyond the powder channels.

The clay stopping in the side holes is dispensed with, and varnished paper alone covers them and the powder channels, which latter are united by quick match at the bottom of the fuze.

This fuze is driven with mealed powder, which makes the interval between two consecutive holes correspond to quarter seconds time of burning.

It will be seen that the marking of this fuze commences at 1 instead of 2, as in the other fuzes, and the side channels are numbered 1, 1.5, &c., thus enabling the fuze to be bored to quarter second intervals instead of half seconds, this being desirable for shrapnel shell for field service. (See cut, page 17.)

The object of closing the head of the fuze is to diminish its rate of burning in rifled guns, and also to prevent its being extinguished on striking point first.

Preparation and action same as diaphragm fuze, except that instead of uncapping, the strip is torn off.

Preparation
and action.

9 seconds *M.L. fuze*, used with S.B. naval shell, R.M.L. common and shrapnel shell, G.S. gauge up to the 80-pr. inclusive;† with shrapnel its use is intended for long ranges. This fuze, though called a 9-second fuze, will, when at rest, burn 10 seconds. It contains 1"·8 fuze composition, above which is driven a pellet ·4" long of mealed powder (equal in time of burning to ·2" fuze composition). This is done to obviate the risk of cracking the composition when boring for short ranges, a result liable to occur when there is only ·2" of composition over the top side hole. The construction and size of this fuze are identical with those of the 5 seconds fuze, except that fuze composition

9 seconds
M.L.O. fuze.
§§ 1236, 2064,
2622.

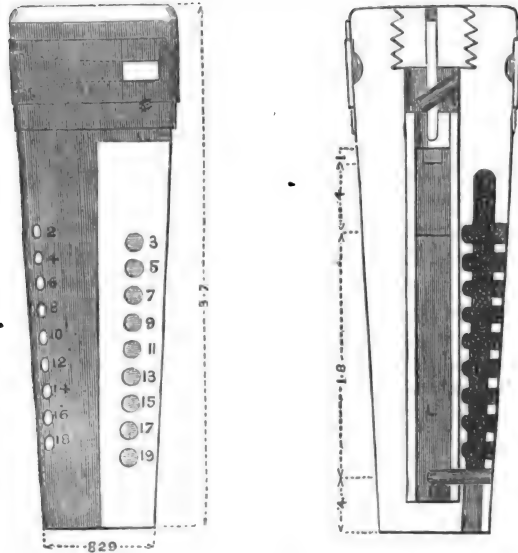
* It is also used with 7-pr. star shell.

† In the S.S. it may be used with the 7" R.M.L. common or double shell when 14 lb. charges are employed. It is also the fuze issued for shrapnel for the 7-inch R.M.L. guns, and upwards in the S.S. Shrapnel shell are not now in the L.S. equipment for these guns. By Army Equipment, 1876, the 9-second fuze is not issued in the L.S. to 64-pr. and 80-pr. guns for use with common shell.

41989.

is used instead of mealed powder, and consequently the side holes are marked to half seconds only, as shown in the sketch.

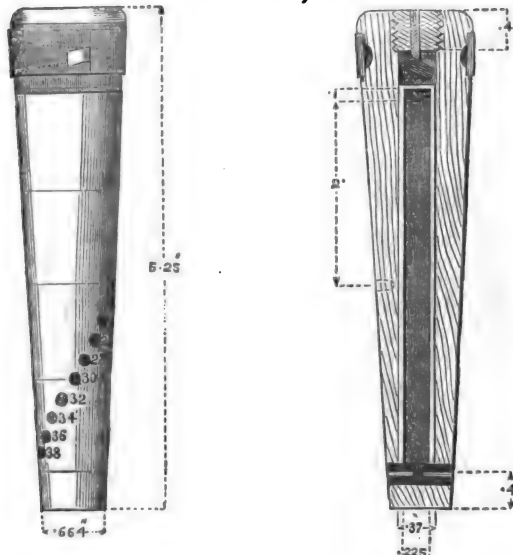
9 Sec. M.L., Mark I.



20 seconds
M.L. fuze.
§§ 1417, 2071,
2485.

20 seconds M.L. fuze, used for S.B.* naval and R.M.L. common shell, G.S. gauge, garrison or naval service, up to the 80-pr. inclusive, at long ranges, also in the F.S. for high angle firing from the 7-pr. gun. It has 4 inches of fuze composition burning 20 seconds. In general construction and action it resembles a mortar fuze, as it has no powder

20 Sec. M.L., Mark I.



* In the S.S. it may be used with the 7" R.M.L. common shell when 14 lb. charges are employed. § 2360, and Errata, 12/72. It is not issued in the L.S to 64-pr. and 80-pr. guns for common shell. Army Equipment, 1876.

channels; but the arrangements as to priming, paper lining, &c., are the same as with other M.L. fuzes. It has a pellet of mealed powder pierced, as shown in the section, to carry the flash from the bottom of the fuze. The marking begins at 20, and only reads to even half seconds, as the marking runs 20, 22, &c.

Mark III., 5, 9, and 20 seconds M.L. fuzes have been sealed. They §§ 2485, 2622. will ultimately be the only M.L. time fuzes used in the L.S., and for boat and field guns in the naval service.

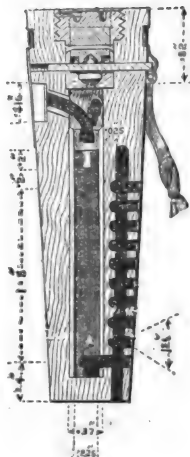
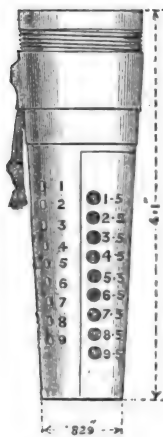
They are more certain of ignition, are less likely to cause prematures, and stand climate better than the previous patterns from which they differ, as follows:—

- (1.) The head projects a little farther from the shell, has a larger groove containing more quick-match priming; and also differs from II. in having a copper band protecting the priming.
- (2.) The paper lining is reduced by one half its thickness, and is coated with varnish. It is hoped that this may prevent the fuzes from deteriorating, as they do now in keeping.
- (3.) The powder channels are brought nearer to the centre of the fuze, and are slightly reduced in length; thus protecting the powder from the chance of being ignited by the discharge of the gun. The side holes are not bored beyond the powder channels, and the last side hole is numbered in these fuzes.

Fuzes of Mark I. (§§ 1236, 1417, 1953) will be retained in the Regulations for issue of M.L. fuzes. service, and supplied to the navy for use with all R.M.L. guns, other than boat and field guns; and also, so long as these fuzes are available in the district, for land service for the 64-pr. and 80-pr. R.M.L. guns only.

Fuzes of Mark II. (§§ 2064–2071) will, until the store is exhausted, be supplied for land service, and for naval service for boat and field guns. Marks II. and III. to be supplied to navy when Mark I. is not available.

5 seconds B.L. fuze, used with B.L. shrapnel shell, G.S. gauge, for 5 seconds B.L. fuze. § 1984.



field service. Construction similar to 5 seconds M.L. fuze, Marks I. and II., except arrangement of head. As there is no windage the fuze has to be ignited by a detonator. A cylinder, of an alloy resembling gun metal, screws into the head of the fuze; this cylinder contains a hammer, supported by a copper wire, below the hammer is a hollow in the cylinder containing a detonating composition, viz., chlorate of potash, 6 parts; fulminate of mercury, 4 parts; sulphide of antimony, 4 parts. A hole is bored through the cylinder for the passage of the flash. A safety pin passes through the head of the fuze between the hammer and the detonating composition, so that the fuze cannot be accidentally fired even if the suspending wire be accidentally sheared. This pin is withdrawn by the braid just before placing the shell in the gun.

There are three escape holes, one shown in the section, to allow of the escape of gas. These holes are protected by thin copper discs and papier mâché plugs, which are forced out by the gas when the fuze is lighted; quick match leads up to these holes. The exterior of the head is woolded with copper wire to keep it from splitting when the detonator is being screwed in.

Preparation
and action.

Same as with the 5 seconds M.L., except withdrawing the safety pin instead of tearing off the strip; the ignition is produced by the inertia of the hammer, causing it to shear the copper wire and fall on the detonating composition, thus exploding it and igniting the fuze.

They are screwed in by hand. Having detonating composition it would be dangerous to strike these fuzes. (See p. 32.)

9 seconds
B.L. fuze, II.
§ 1999.

9 seconds B.L. fuze, used with B.L. common and segment shell, G.S. gauge, for garrison and naval service, and with shrapnel for field service at long ranges.

Construction is identical with that of the 9 seconds M.L., Marks I. or II., except the head, which is the same as has been described for the 5 seconds B.L. fuze.

20 seconds
B.L. fuze, II.
§ 1999.

20 seconds B.L. fuze, used with B.L. common and segment shells, G.S. gauge, garrison or naval service at long ranges; identical with 20 seconds M.L. fuze, Marks I. and II., except arrangements of head, which are the same as in 5 and 9 seconds B.L. fuzes.

§§ 873, 1417.

Mark I., 9 and 20 seconds fuzes were made without a safety pin, but having kamptulicon discs on the top and bottom. Before fixing, the disc should be removed from the bottom of the 9 seconds, as shrapnel shell have failed to ignite with these fuzes, owing to the disc being blown on to the top of the primer, and thereby preventing the latter from igniting.

N.B.—All the B.L. fuzes are a little longer than the M.L. fuzes, owing to the detonating arrangement.

Proof of Fuzes.

Proof of fuzes.

About $\frac{1}{2}$ 2 seconds is allowed on every 5 seconds time of burning when the fuzes are new, but fuzes that have been kept some years will generally burn longer. No minus limit is allowed for mortar and hand grenade fuzes.

Fuzes are to be condemned which burn 10 per cent. over their proper time; thus 5 seconds fuzes are condemned if they burn 5.5 seconds, 9 seconds fuzes if they burn 11 seconds, and 20 seconds fuzes if they burn 22 seconds. When Firemasters ascertain that fuzes burn long, the fact should be communicated to officers carrying on practice. Extracts, vol. xi., p. 82.

Short Rule for getting Length of Fuze.*

Divide the number of hundreds of yards in the range by 2 and add 1 up to 1,000 yards, 2 up to 2,000 yards, and so on for length of fuze in tenths of inches ; this will be found nearly correct with rifled ordnance. Example : To find length of fuze at 2,600 yards for 16-pr. gun, $\frac{26}{2} + 3 = 16$.

Shrapnel require to be bored a little shorter.

N.B.—Blind shell are frequently due to the fuzes being bored too long. If old fuzes, which burn long, are bored according to the range table, blind shell may be expected ; hence, if blind shell occur, try a shorter fuze.

Short Rule for getting Length of Fuze for Mortars.

Add 17 to the number of hundreds of yards in the range for the length of fuze in tenths of inches, thus the fuze for 1,700 yards will be 3''4.

Pettman's Percussion Fuze, L.S.

Pettman percussion fuze, L.S., used with common shell of common gauge. The fuze hole must be tapped through-out to receive this fuze ; this is indicated by a cross cut on the plug.

The body of the fuze is made of gun metal ; the ball, cone plug, and steady plug of a harder alloy to strengthen them ; the remaining parts are gun metal, except the lead cup.

The section (*see cut*) shows the construction.

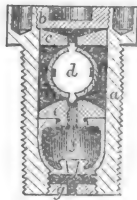
A strand of quick match closes the fire hole in the bottom plug.

No preparation is wanting with this fuze, which explodes the shell on its striking a hard body, such as a wooden ship, wall, &c. It is not intended to act on graze. (*See p. 12.*)

The ball is the only part of the construction which is not quite explained by the sketch ; it is roughened by vertical grooves and has a horizontal groove as well ; it is coated with a detonating composition composed of chlorate of potash, 6 oz. ; sulphide of antimony, 6 oz. ; sulphur sublimed, $\frac{1}{2}$ oz. ; mealed powder, $\frac{1}{2}$ oz., made into paste with methylated spirits and shellac. Varnished gut is tied over it, and a cover of varnished silk over that ; these covers both keep off damp and prevent premature explosion.

On firing, the shock of discharge crushes up the lead cup, the ball, cone plug, and steady plug setting back ; the sketch shows how the lead cup dovetails on to the cone plug and bottom plug, preventing rebound ; the steady plug prevents the ball touching the sides as it sets

Pettman L.S.



- a. Body.
- b. Top plug.
- c. Steady plug.
- d. Detonating ball.
- e. Cone plug.
- f. Lead cup.
- g. Bottom plug.

Pettman's
percussion
fuze, L.S.

* The rate of burning varies, not only with the age of the fuze, but also with the pressure of the air, the greater the pressure the quicker the fuze burns. Fuzes were found to burn slowly in Abyssinia owing to the height above the sea, therefore all rules for the length of fuze must be taken as approximations, to be corrected by observation. Each diminution of atmospheric pressure to the extent of one mercurial inch increases the time of burning by $\frac{1}{10}$. The barometer falls about one inch for an increase of 1,000 feet in elevation. Thus at 5,000 feet elevation, the time of burning of a large mortar fuze would be increased by about $\frac{5}{10}$, and would therefore burn about 85 seconds. The time of burning varies slightly in different guns, generally the rate is quicker in large than in small guns.

† See note, p. 12.

back, and the irregular motion of the shell in the air causes it to disengage from the ball. On the shell striking the object, the ball, now unsupported, is dashed violently against the side of the body, explodes the detonating composition and fires the shell, the flash passing through holes in the cone and bottom plugs.

Issue.

These fuzes are packed by fives in tin cylinders.

Pettman Percussion Fuze, G.S.

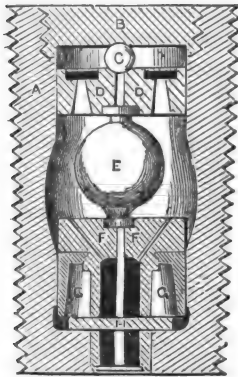
Pettman's G.S.
fuze.
§ 1235.

Pettman G.S. percussion fuze, used with naval spherical shell and common and segment shell,* G.S. gauge, of the garrison calibres for rifled guns. To understand the construction of the fuze it is necessary to know the points aimed at. (1.) To enable the shell to pass through a wave without exploding, and yet to burst in a wooden ship. (2.) To ensure its action whether fired out of breech or muzzle-loading guns. The motion of a shell from a B.L. gun is so steady that the steady plug does not always disengage from the ball in flight as is the case with M.L. smooth bore or rifled guns.

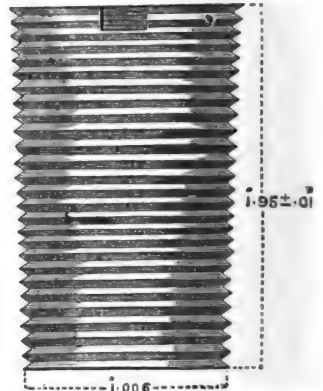
The first object is obtained by covering the ball with two hemispheres of thin copper, in addition to varnished gut and two thicknesses of silk.†

The second is obtained by the addition of the plain ball, and by altering the steady plug from its form in the L.S. fuze. A ring of detonating composition runs round near the outer edge, and is covered with thin copper for the same reason as the ball.

Pettman Percussion, General Service Fuze.



- A. Body.
- B. Top plug.
- C. Plain ball.
- D. Steady plug.
- E. Detonating ball.
- F. Cone plug.
- G. Lead cup.
- H. Suspend wire.



The shape of the cone plug is also altered, and so is its method of support. It is supported by a copper pin; the lead only acts to check rebound, dovetailing into the cone plug and undercut groove in the body; the cone plug is primed with mealed powder driven and pierced, and the interior of the body is enlarged so as to give more play for

* The garrison segment shells take R.L. percussion fuzes in L.S.

† Owing to the deterioration undergone by these fuzes owing to the copper hemispheres being immediately in contact with the composition, in future the balls will be covered with gut, two thicknesses of silk, the copper hemispheres, gut, and, lastly, three layers of silk. The steady plugs will be lacquered. Fuzes thus made will be Mark II.

the detonating ball.* The bottom of the cone plug and the hole at the bottom of the fuze are closed with paper wads shellaced over. The top and bottom of the fuze are thickly coated with a waterproof composition, these fuzes stand soaking some hours in water without injury.

The very ingenious arrangement of this fuze is necessary to meet the difficulty of getting a fuze to act with rifled guns of both natures and also smooth bores. For rifled guns only, a much simpler arrangement answers.

(1.) Suppose a shell fired out of a M.L. gun, the steady plug, ball, and cone plug set back on shock of firing, the wire H is broken, the lead cup prevents rebound, and the stem of the cone plug F protrudes through the base of the fuze; on striking, the action will be the same as in the L.S. fuze, the flash finding exit through the holes in the cone plug to the priming and thence to the powder in the shell.

(2.) When fired from a B.L. gun the steady plug may not disengage, and the detonating ball will not act; the plain ball C is released by the steady plug setting back, and is caused by the centrifugal force to spin round the circumference of the body over the ring of detonating composition. On shock of striking the object, the ring is dashed against the plain ball and detonates, exploding the shell through the fire holes.

These fuzes are packed by fives in tin cylinders.

This fuze being specially designed for firing over water is issued to sea fronts of fortifications and to the Royal Navy. § 2359. Issue.

Fuze, Percussion, B.L. plain.†

Used with field service B.L. common and segment shell. This is a modification of the Armstrong C. percussion, the improvement consisting in using cap composition pressed and varnished, as in gun caps, which experience has shown to stand damp climates well. § 1983, 2620.

The body is made of gun-metal, and has a rim projecting at the top which ensures the fuze being placed in the correct position in the shell, i.e., not upside down. In the centre of the top, on the inside, is fixed a steel needle, point down; the top is pierced with four holes to allow of the action of the Armstrong time fuze, which is still used in the navy in conjunction with the B.L. plain fuze. Construction.

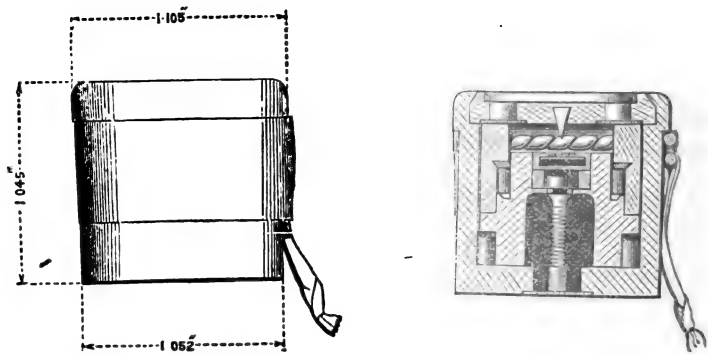
A washer of thin sheet brass closes these holes (it is blown in by the action of the time fuze).

The guard, consisting of a gun-metal collar pierced with two holes for the safety pin, fits inside next the top; it is recessed inside to receive the head of the pellet; there is a slight undercut at the top of the recess into which the pellet expands when the guard sets back.

The pellet is cast of equal parts of lead and tin; it is hollowed out and receives in its top the copper cap, which is primed with cap com-

* Some Pettman G.S. fuzes which have been repaired at out-stations may be met with, and should be returned to Woolwich. The detonating ball and small plain ball may be out of position and the fuze, consequently, unsafe. Those examined and secured with composition at Woolwich may be known by the date of repair and the letter R. (reprimed) or S. (secured) being printed on the label. New fuzes from 434th thousand will be considered serviceable. Fuzes which have been in shells will not be considered serviceable. Fuzes not having R. or S., if bearing a lower number than 434, are to be returned to Woolwich. These remarks do not apply to Mark II. § 2359.

† By § 2029 a number of obsolete fuzes were called in to be converted to the C. "cap," (since called "B.L. plain,") percussion fuze. They are easily known, as none of them have a safety pin with braid attached to it. When converted, "cap" is stamped on them.



position (fulminate of mercury, sulphide of antimony, and chlorate of potash), pressed and varnished in the same way as in gun caps. The composition is further protected by a very thin disc of brass; this has been found necessary to prevent premature explosions; a disc of paper coated with shellac is stuck on the top of the pellet covering the cap.

The cap is pierced with three small holes, so arranged round the centre as not to interfere with the action of the needle; these holes allow the flash to pass down to the lower part of the pellet, which is filled with pressed powder pierced like a tube and roughened so as to ensure ignition.

On the exterior of the pellet are four feathers or flanges, and below the pellet a disc of paper is placed to prevent its adhering to the bottom of the fuze.

The bottom consists of a gun-metal disc which screws into the base of the fuze; in the centre is a small recess which contains powder driven and pierced as usual. This recess is closed on the exterior by a thin brass disc.

The safety pin is made of twisted brass wire, and has a piece of braid attached to it to enable it to be withdrawn readily; a little beeswax is applied to seal the hole, and the tape is secured by a paper strip shellaced round the fuze.

§ 2169.

Since 12/71 these fuzes have been painted with a black varnish, similar to that used with friction tubes, in order to exclude damp as much as possible.

Preparation.

Remove the safety pin and drop the fuze into the shell, rim uppermost; replace the plug in the shell, except for naval service, when the E. time fuze is used.

Action.

When the safety pin is removed, the guard is supported by the feathers of the pellet; on the shock of discharge the guard sets back, shearing off the feathers, and on striking the object, or on grazing, the pellet and guard fly forward, the cap comes in contact with the needle and explodes the fuze.

This fuze may be depended on to act on graze even on wet boggy ground or on water, and will act at 400 yards where case shot ceases to be effective. It may be noted that short ranges are most trying to this

* The cut represents an earlier pattern converted; the present pattern has the bottom screwed into the body.

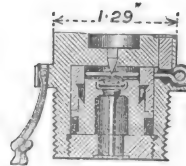
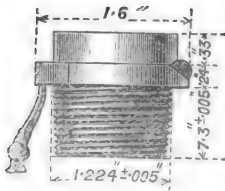
class of fuze, as the graze then gives but a slight check to the velocity of the shell. Before the addition of the safety pin the feathers of the pellet were found apt to give way under the jolting to which the fuze was exposed in limber boxes; but now the fuze is quite safe, as the pin takes the part of the lead feathers, which are only called into play when the pin is withdrawn.

In tin cylindrical boxes, holding two fuzes, each fuze in a water-proof bag, 80 tin boxes, or 160 fuzes in a deal packing case. These fuzes will be issued in tin cylinders (5 in each) when the present store of cylinders is used up. Issue.

For field service, 20 fuzes are carried on their sides in a tin box.

Royal Laboratory Percussion Fuze, Mark I.

Used with R.M.L. field service 7 and 9-pr. common and shrapnel §§ 2191, 2620. shell. This fuze exactly resembles the B.L. plain percussion fuze in its internal arrangements and action. The body is of gun metal, both body and top are cast in one piece, the bottom is screwed in, a square hole in the head fits the key plug, G.S., by which it is screwed into the shell. This fuze fits the G.S. gauge.



As the hole for the safety pin is exposed to the flash of the discharge, it has been found necessary to insert a lead pellet above the safety pin; on ramming home, this pellet sets back and closes the safety pin hole.

The safety pin is a plain brass wire with a brass wire ring which fits round the neck of the fuze; the ring has a braid attached to it, and it is kept in its place by pasting a slip of paper over the braid. The pin is not to be withdrawn until the shell is placed in the bore.

This fuze of course acts on graze in the same way as the B.L. plain percussion.

Five fuzes in a tin cylinder, each fuze wrapped in brown paper, and 6 cylinders packed in a deal case. Issue.

For field service, 16 fuzes are carried on their sides in a tin box §§ 2201, 2328. for the 9-pr., and 12 fuzes for the 7-pr.

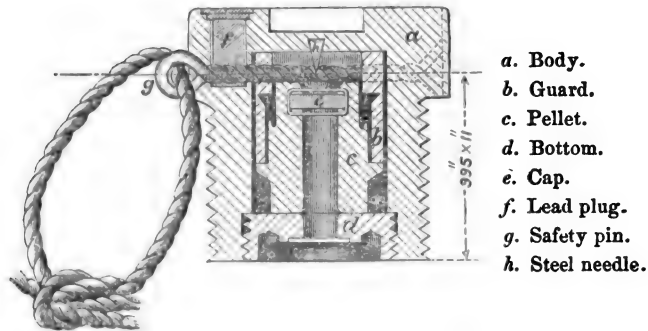
*Fuze, Percussion, R.L., Mark II.**

This fuze is for use in the land service with all rifled B.L. shells having the "general service" fuze-hole, and all rifled M.L. shells up to 80-pr. inclusive, and in the sea service with 7-pr. and 9-pr. rifled M.L. shells only, with the exception in both services of 7-pr. double

§ 2621.

* Mark I. fuze was found to fail in calibres above the 9-pr., the case not being strong enough to stand the shock of discharge.

shells, as the small charge (4 ozs.) used with these shells will not set it in action (*see cut*).



This fuze differs from Mark I. in the following particulars:—

1st. The pellet and guard are smaller in diameter, to admit of greater thickness in the side of the fuze, and of a deeper screw thread at the bottom, thereby giving the base greater power to support the weight of the pellet and guard on the shock of discharge.

2nd. The pellet has no powder pressed into it, and there is an increased quantity of detonating composition in the cap at the top of the pellet. The fuze is thus made quicker and more certain in its action.

3rd. The safety pin (of double twisted wire) passes through the head of the fuze, and is kept in its place by the two ends being opened out slightly, so as to bind themselves in a conical cup, as shown in the drawing. A thin disc of brass is then fitted in over the ends, and soldered over to keep the fuze water-tight. The head of the safety pin is fitted with a loop of string, by which it is withdrawn. There is no brass ring or recess round the head of the fuze.

Fuzes of Mark I. are only suitable for use with 7-pr. and 9-pr. guns; but for these natures they are as efficient as the Mark II. fuzes. All issues for these two natures of guns will therefore be taken from the existing store of Mark I. fuzes until it is used up.

As given for Mark I. When used with B.L. guns, the safety pin must be taken out before placing the shell in the bore.

Preparation,
action, and
issue.

Special Fuzes.

- (1.) Hand grenade fuze.
- (2.) Parachute, light, 10 inch.
- (3.) " " 8 "
- (4.) " " 5½ "
- (5.) Life-saving rocket.
- (6.) Fuze, Abel's electric.

Hand grenade. *Hand Grenade.*—Used with 3 or 6-pr. hand grenades; burns 7½ seconds; they are placed in the grenade, uncapped, and lighted by a portfire.

Issue. 1,200 in a half metal lined case.

10-inch parachute light fuze.—Has 3 inches of fuze composition burning 15 seconds. Its marking is different to the service fuzes, thus 6 on it means 6 seconds. 10-inch parachute.

8-inch parachute light fuze.—Has 2 inches of slow burning composition and burns 13 seconds. These two fuzes on emergency might be used with S.B. common shell. 8-inch parachute.

5½-inch parachute light fuze.—Has 1½" slow composition, burns 10 seconds. Too small for use with S.B. common shell. 5½-inch parachute.

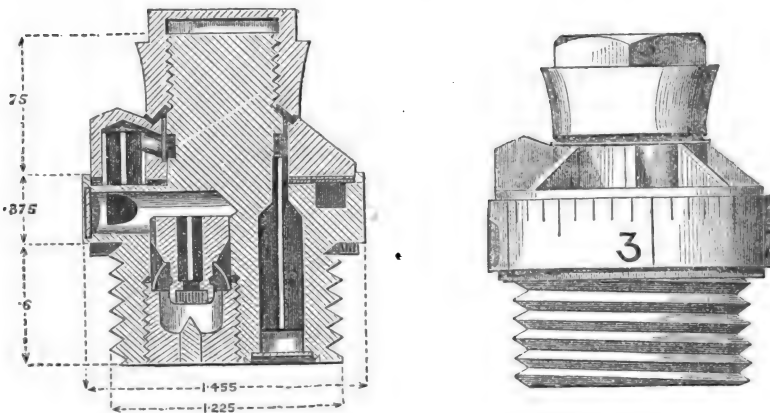
The parachute fuzes are painted blue, and have been up to the present time issued 50 in zinc cylinders. Paint and issue.

Fuze for firing life-saving rocket has one inch and a half of slow burning composition in a kamptulicon case; it burns 10 seconds, and is used to ignite the rocket, a portfire is used to ignite the fuze; the fuze fits into the vent of the rocket.* Fuze, life-saving rocket.

Fuze, Abel, electric, is merely the head of the electric tube described on page 57, the tube not being adapted for firing mines; the head is pressed with mealed powder. It is used for firing mines, torpedoes, &c., by electricity. If gun cotton be used, the fuze must become a detonator, the electrical arrangements remaining the same. "Low tension" electric tubes, &c. are now most generally used. Fuze, Abel, electric.

Armstrong E. time fuze.—Used only by the navy, with B.L. field service segment shell. Armstrong time fuze.

As this fuze is still in store it is well to give a short description of it. Its general construction will be understood by the sketch.



Both body and nut of the last pattern, E. III., are made of gun § 2496. metal, and the graduations for length of fuze in inches and tenths are marked on the metal rim instead of on paper, as in former patterns. The pellet, which is supported by a brass cup, is filled with R.F.G. powder, secured by thin paper fastened on its base; the detonator in § 2178. in the head consists of cap composition (fulminate of mercury, chlorate of potash, and sulphide of antimony), instead of the amorphous phosphorus composition which deteriorated in damp climates. In those lately made a disc of brass .001" thick covers the detonating composition. The word "cap" is stamped on the base of the fuze.

The channel by which the flash from the pellet reaches the ring of fuze composition is enlarged in this pattern, and a little hole is bored in

* Mark I. fuze burnt 5 seconds.

the ring of fuze composition to ensure its lighting. The fuze composition is pit mealed powder pressed into a ring or groove which runs round close to the exterior of fuze body; this composition burns at the rate of 1 inch in 2 seconds, and owing to a metal stop can only burn in one direction, *i.e.*, from left to right.

A leather washer and movable gun-metal collar cover the ring of composition. At one part of the collar, a channel (primed with mealed powder driven and pierced) communicates with a groove round the neck of the fuze, which contains mealed powder; this groove is connected by a channel with the blowing chamber which is primed with mealed powder, driven and pierced; a small brass disc closes the chamber.

The movable collar is kept in its place by a nut which screws on to the neck. The body has a small hole in the side to fit a projection in the Armstrong key used in screwing in the fuze.

Preparation.

See page 32.

Action.

On firing the gun, the brass cup is crushed in, the pellet strikes the needle, which explodes the detonating composition, the ring of fuze composition is ignited by the flash and burns till it comes to the channel, marked by the arrow head, leading to the groove in the neck primed with mealed powder, the flash is then instantaneously conveyed into the blowing chamber, and thence into the shell.

The changes recently introduced, particularly the cap composition and the ensuring ignition by piercing a hole in the ring of fuze composition, have greatly improved this fuze.

Short rule for
finding length
of fuze.

Divide number of hundreds of yards in range by 6 for length in inches, thus for 1,200 yards, length of fuze = 2 inches.

Issue.

1 in a waterproof bag placed in a cylindrical tin box wrapped in brown paper, 72 boxes in a deal case placed on the sides or heads, the bottom of each tin box is marked "top" to prevent it being placed downwards.

CHAPTER III.—SHELL AND FUZE IMPLEMENTS.

DISTRIBUTION OF AND INSTRUCTION, IN THE USE OF, SHELL AND
FUZE IMPLEMENTS.—PAPIER MÂCHÉ WADS—WOOD BOTTOMS.

SHELL and fuze implements are issued, as their name implies, for preparing shell and fuzes. There were formerly five sets for garrison service, four sets for field service, S.B., and one set for rifled guns of position. By the last regulations, "Errata and Addenda to Army Equipment, 1876," issued July 1877, "sets" of implements are abolished, and implements are to be demanded separately. The detail will appear in the following pages.

IMPLEMENTS FOR RECTIFYING FUZE-HOLES OF COMMON (S.B.) AND DIAPHRAGM SHRAPNEL SHELL.

One set per station, two sets if large station.

Blocks, wood, 10-inch, 8-inch, 32-pr. (of each)	-	1
Gauges, fuze-hole, common	-	1
Holder, shell, spherical	-	1
Key, iron, square	-	1
Levers, common	-	1
Rectifier, or rimer, common, fuze-hole	-	1
Screws, coach, 4 in. by $\frac{1}{2}$ in.	-	4
Tap, screw, Pettman, common	-	1

IMPLEMENTS FOR RECTIFYING FUZE-HOLES OF MORTAR SHELL. (Issue as above.)

Blocks, wood, 13-inch	-	1
Gauges, fuze-hole, mortar	-	1
Holder, shell, spherical	-	1
Levers, mortar	-	1
Rectifier, or rimer, mortar, fuze-hole	-	1
Screws, coach, 4 in. by $\frac{1}{2}$ in.	-	4

All the above implements will be retained only where shells still require to be rectified, and will cease to be recognised as part of the equipment for future issue.

RECTIFYING FUZE-HOLES.

S.B. Shell, Common.—Unscrew the metal plug from the fuze-hole by means of the square key and lever [if the plug should be so firmly fixed in the shell that it cannot be unscrewed by the key, a few smart blows with the hammer will loosen it], insert the fuze-hole gauge—if the larger end of the cone is not flush with the exterior of the fuze-hole, place the shell in the holder, and fix it by screwing up the movable jaw—the smaller natures of shell can be supported by hand in the proper position until the jaws have a firm hold; but for the 32-pr. and heavier natures a block of wood is necessary for the shell to rest upon; the jaws should grip the shell about half-way between the fuze-hole and the bottom—insert the rimer into the fuze-hole, and turn it gently round with the lever until the fuze-hole is of the proper dimensions, *great care being taken not to make it too large*, then perfect the thread by means of the screw-tap. The shell-holder when in use must be screwed to a bench or table.

Instructions,
No. 1 set.

S.B. Shell, Mortar.—Remove the cork from the fuze-hole and insert the fuze-hole gauge. If the larger end of the cone is not flush with the exterior of the fuze-hole, place the shell, resting on a block of wood, in the holder, and proceed as above until the fuze-hole is of the proper dimensions, *great care being taken not to make it too large*.

IMPLEMENTS, S.B. GARRISON, FOR FIXING WOOD BOTTOMS.

One set per shell filling room, where spherical shell are prepared.

Block, wood	-	1
Hammer, riveting	-	1
Pricker, removing wax	-	1
Punch, iron, riveting bottoms	-	1
Rectifier, common, for rivet-hole	-	1
Spanner, box	-	1

FIXING WOOD BOTTOMS.

Instructions,
No. 2 set.

S.B. Shell, Common.—Remove the bottom from the iron bar by unscrewing the nut at the end of the bar with the box spanner; place the shell on the wood block; remove the beeswax from the rivet-hole with the pricker; place the rivet in the rivet-hole of the wood bottom, with the point projecting beyond the concave surface; place it on the shell, moving it about until the rivet drops into the rivet-hole; place the punch on the head of the rivet and give it a few smart blows with the hammer.

If the rivet-hole in the wood bottom is rough and jagged pass the rectifier through it, turning it round so as to bring the hole to its proper form.

The common shell, which are issued loose, have the fuze-hole secured by a metal screw-plug, and are prepared with rivet-holes for fixing the wood bottom. The wood bottoms are packed by twenties on iron rods, and secured by an iron nut.

IMPLEMENTS, S.B. GARRISON, FOR FILLING S.B. COMMON, DIAPHRAGM SHRAPNEL, AND MORTAR SHELL.

One set per shell filling room.

Drifts, wood, common	-	-	-	-	1
" " diaphragm shrapnel, large	-	-	-	-	1
" " " " small	-	-	-	-	1
Drivers, screw, diaphragm shrapnel, large	-	-	-	-	1
" " " " small	-	-	-	-	1
Funnels, leather, copper spouts, common, large	-	-	-	-	1
" " " " diaphragm shrapnel, large	-	-	-	-	1
" " " " diaphragm shrapnel, small	-	-	-	-	1
Key, iron, fuze and plug, G.S.	-	-	-	-	1
Mallets, common and diaphragm	-	-	-	-	1
" mortar	-	-	-	-	1
Instructions, printed, sheets	-	-	-	-	2

The following implements are supplied for filling common, Palliser, segment, and shrapnel shell for rifled ordnance of garrison calibres:—

Mallets, tent, 2 per shell filling room.

Funnels, copper, shell, large, 1 per shell filling room, 7-inch R.M.L. guns and upwards.

Drivers, screw, diaphragm shrapnel, large, 1 per shell filling room.

Extractors, fuze, small, 1 per shell filling room.

Funnels, common, large, 2 per shell filling room.

Holders, Palliser shell, 1 per shell filling room for each nature of Palliser shell.

Instructions, sheets, 2 per shell filling room for R.M.L. or R.B.L., as required.

Key, iron, fuze and plug, G.S., 2 per shell filling room.

Wrench, removing, plug, 1 per shell room, for Palliser shell only.

Rods, brass, for filling shell, 1 per shell filling room, 7-inch R.M.L. guns and upwards.

Block, wood, or shell holder, 1 per shell room, for Palliser shells only, to be made locally.

FILLING AND SECURING SHELLS.

Shells, Spherical, S.B., Common.—Remove the plug from the fuze-hole by means of the key; insert the funnel and pour in the bursting-

charge; carefully wipe every portion of powder from the fuze-hole, and drive in a papier mâché wad with the drift as far as the shoulder on the drift will allow; * then screw in the fuze-hole plug, or gun fuze, as required.

Shells, Spherical, S.B. Diaphragm Shrapnel, Boxer.—Remove the plug from the loading-hole by means of a screw-driver; hold the shell in a position with the loading-hole uppermost; insert the funnel and pour in the bursting-charge; turn the shell from side to side to facilitate the filling; carefully wipe every portion of powder from the loading-hole, and drive in a papier mâché wad with the drift as far as the shoulder on the drift will allow, and screw in the plug; unscrew the fuze-hole plug, to which is attached a wood plug covered with serge (to prevent the bursting powder from passing into the socket in sufficient quantity to cause inconvenience in fixing the fuze); and in order to insure the small hole communicating with the powder-chamber being clear, shake a few grains of powder from the powder-chamber into the socket; then replace the fuze-hole plug.

Shells, Spherical, S.B., Mortar.—Mortar shells are only filled when required for firing. Remove the cork from the fuze-hole, except in the case of the 10 and 13 inch, when it may be driven in; insert the funnel and pour in the bursting-charge, and insert the fuze as described under head of "preparing fuzes."

Shells, Rifled, M.L., Common, under 7-inch.—Remove the plug from the fuze-hole, insert the leather funnel and pour in the bursting-charge; the shell should be tapped with a mallet or a piece of wood to ensure its being completely filled, just leaving room for the fuze if it is to be fuze with a time-fuze, this can be ascertained by inserting a piece of wood the same size as the fuze; after filling the shell carefully wipe every portion of powder from the fuze-hole, then fix the fuze or plug as may be required.

In shells for siege, field, or boat service, that are liable to be travelled, insert the wad, papier mâché, G.S., with the side on which the shalloon is cemented downwards, i.e., next the powder; drive it in with the "Drift, wood, G.S.," as far as the shoulder on the drift will allow, and then screw in the plug.

Shells, Rifled, Shrapnel, Boxer.—Remove the plug from the fuze-hole, and after seeing that the fuze-hole is clear of any dirt, &c., insert the leather funnel and pour in the bursting-charge. This must be done gradually, for if the whole of the powder is put in at once the tube will probably become choked. Shake the shell from side to side on its base, until the whole of the bursting-charge has passed down the tube, taking care that none of the powder is left at the bottom of the socket. Drop in the metal primer and, by means of the large diaphragm shrapnel screwdriver, screw it tightly into the tube, and then screw in the fuze or plug as may be required.

Shells, Rifled B.L., Common and Segment.—The common and segment shells, 40-pr. and upwards, and the 20-pr. sea service common shell, are to be filled as directed for R.M.L. common shell under 7-inch. In the common shell, 20-pr. land service, 12-pr. and 9-pr., which are fitted with a metal socket to carry the B.L. percussion fuze, insert the leather funnel and carefully pour in the bursting-charge through the small hole at the bottom of the socket until the shell is thoroughly filled, then (care being taken that no powder remains in the socket), place the papier mâché wad, recessed part uppermost, in the hole at

* Applies to shells not wanted for immediate service, or to travel.

the bottom of the socket, and drive it in flush; any flat-ended piece of wood or stick larger in diameter than the wad can be used for this purpose, then fix the fuze or screw in the fuze-hole plug as may be required.

The object of this wad being used is to prevent the powder from working up into the socket after the shell has been filled.

The 20-pr., 12-pr., and 9-pr. segment shells have iron bursters, a wood plug covered with serge being placed on top to secure them whilst travelling: this plug is to be removed when the percussion fuze is inserted.*

Shells, Rifled, M.L., Common, 7-inch and upwards.—Remove the plug from the fuze-hole, place the filling-rod in the bag, and fold the latter round the rod, insert it through the fuze-hole, taking care not to force the end of the rod through the bottom of the bag; carefully push in the bag until the neck only is in the fuze-hole, a portion being kept outside, as the whole bag must not be allowed to slip into the shell during the operation of filling; then withdraw the rod and insert the funnel in the neck of the bag, pressing the funnel well down into the fuze-hole; pass the filling-rod down through the funnel and *gradually* pour in two or three pounds of powder; take out the funnel and rod, lift up the bag and jerk it, so as to “set” the powder well down to the bottom and to open the bag. Then reinsert the funnel and rod as before and continue the filling.

The filling-rod should be moved up and down to facilitate the passage of the powder through the funnel; the powder in the shell being tamped on at the same time. The use of a large mallet against the side of the shell (or any piece of wood that would answer the same purpose) will materially assist in getting as much powder as possible into the shell.

When the shell is quite full,† withdraw the funnel and filling-rod and tie the neck of the bag with two half-hitches of twine close to the top of the fuze-hole. Cut off the superfluous choke and push the neck of the bag well down, and to one side of the fuze-hole; then screw in the fuze or plug as required.

When the shell is to be fuzed with a time fuze it must not be quite filled with powder, but sufficient space must be left for the insertion of the fuze when the choke of the bag is pushed in.

No preparation of the bag by pricking or otherwise is necessary when using either percussion or wood time fuzes, except in the case of the 20 seconds fuzes, which require that the bags should be pricked. A sharply pointed piece of wood should be used.

Shells, Rifled, M.L., Palliser.—The shell is to be placed upon its point, which may be inserted in a block of wood hollowed for the purpose, or in any convenient place to steady it. No special pattern of block is necessary; it can be provided on the spot and the recess cut by any carpenter.

* The bursters are issued wrapped up in brown paper; this covering should not be removed, but only the top end should be torn off to allow ignition. If the shell have not a small lead disc permanently secured at the bottom of the bursting chamber, one should be inserted before putting in the burster. Shell which have these discs permanently secured in them are marked with the letter D. on the coat. This does not apply to shell for S.S., in which service the E. time fuze is used.

† It is very important, particularly with the larger natures of shell, that they should be completely filled. Great care must be taken to keep both the shell and mallets free from grit, to allow no loose powder to be spilled, and it is well to keep the floor damp.

To remove the plug the "Holder, shell, Palliser" is to be slipped over the base until it rests on the bottom studs, and then held firmly by one man while another applies the "Wrench, removing, plug" to the plug and unscrews it. The bag is then inserted and the shell filled as directed for the larger natures of R.M.L. common shells. Before replacing the plug, any grains of powder or grit adhering to either screw must be thoroughly removed. The plug is to be screwed home as hard as possible, and the key-hole filled with red-lead putty.

When empty Palliser shells are kept at the guns, where the plug is liable to become set fast by corrosion from the action of salt water, the base should be unscrewed once at least every six months, and the screw coated with a mixture of equal parts of cocoanut oil and finely powdered chalk.

Fixing Plugs and Fuzes.—When plugs or metal fuzes are screwed into shells they should be lubricated with a mixture of equal parts of cocoanut oil and finely powdered chalk.

Distinguishing Marks.—All filled shells must be marked with the word "Filled"* and date, and also "bag"* if a bag is used.

IMPLEMENTS FOR PREPARING FUZES.

1 set per gun, 64-pr. or 80-pr. R.M.L., and 40-pr. or 7-inch R.B.L.

1 set for every two pieces of S.B. ordnance.

The set contains the following implements, which are to be demanded separately:—

Bits, hook borer	-	-	-	-	6
Borer, hook, with handle	-	-	-	-	1
Cylinder, wood, common	-	-	-	-	1
Instructions, printed sheets, to every two pieces	-	-	-	-	1
Key, iron, fuze and plug, G.S.	-	-	-	-	1

PREPARING FUZES.

Fuzes, Time, Wood, Boxer.—The Boxer wood time-fuzes are prepared for any desired time of flight by boring through the side-hole corresponding to the required time into the composition.

When using the hook borer, place the fuze in the hook in the proper position for boring the required hole,† enter the bit into the side-hole, screwing up until the bit has entered as far as the borer will allow, taking care not to press upon the fuze so as to prevent its bedding fairly in the hook.

Unscrew, and when the bit is quite clear remove, the fuze from the hook. The length of the bit is so regulated that, when placed in the handle it will enter sufficiently far into the composition when screwed down to the shoulder. If the bit should become unserviceable the handle must be detached from the shank and the tightening screw unscrewed, the square hole in the hook being made for that purpose.

* These words, &c. to be stencilled in red on the head of the shell, except in the case of the shrapnel shell, which have red heads; on these the stencilling is to be black.

† Head of fuze should be towards the body, the handle of the borer being worked with the right hand.

When using the hook borer with such a fuze as the small mortar or 20 seconds, great care must be taken to prevent the fuze turning to one side; if this is not attended to the bit may pass to one side of the composition, specially when boring near the small end of the cone.

Care must be taken when substituting another bit that it is properly placed in the handle, *and that the tightening screw firmly presses upon it, for if any space be left between the handle and the head of the bit the end will not enter a sufficient depth into the composition.* The borer should be occasionally examined and cleaned. The operation of preparing the fuze and fixing it in the shell takes, on an average, about 15 seconds; with a little practice these operations may be performed in a shorter time.

When using the gimlet borer, hold the fuze in the hollow of the hand, enter the borer into the side-hole, pressing it in perpendicular to the axis of the fuze; when it has reached the bottom of the hole, use it as a gimlet to complete the communication with the composition, boring up to the handle; then pull the borer straight out.

Fuzes, Time, Metal, Armstrong, E.—The Armstrong metal time fuzes are prepared for the desired time of flight after they have been screwed into the shell.

Loosen the nut with the key so as to free the collar. Hold the shell in the right hand and move the collar with the forefinger and thumb of the left hand, until the arrow points to the required length of fuze; then screw up the nut with the right hand, steadying the collar at the same time with the left hand. Finally, tighten the nut with the key, or by inserting it in the socket on the axletree-box, giving the shell a slight turn towards the trail. Should the fuze be taken from the shell, the collar must be set at the "blank" before it is replaced in the box.

FIXING FUZES.

Fuzes, Time, Wood, Boxer, Common and Diaphragm.—Remove the fuze-hole plug and place the fuze in the fuze-hole of the shell, and give the head of the fuze two or three smart taps with the mallet, or against the gun carriage if more convenient. Before the fuze is placed in the socket of the diaphragm shell, care must be taken to remove any superfluous quantity of powder which may have passed into the socket through the communication hole. This is important, because the shell will burst prematurely if the powder in the socket prevent the fuze being securely fixed.

The fuze should not be uncapped until the shell is placed in the muzzle of the gun; this much reduces the chance of an accident and secures the priming from injury.

Fuzes, Time, Wood, Boxer, Breech-loading.—The fuzes for B.L. shells should be screwed into the fuze-hole by hand: when they cannot be screwed any further they are properly secured. *In fixing the B.L. Boxer time-fuzes, neither a mallet nor any other instrument is to be used.* The safety-pin is not to be withdrawn until just before entering the shell into the breech.

Fuzes, Time, Wood, Boxer, Muzzle-loading.—The fuzes for muzzle-loading shells are fixed in the fuze-hole by screwing the fuze round by hand until it is held firmly in the fuze-hole, or in the land service by giving the head of the fuze two or three smart taps with a mallet, or suitable piece of wood, or (with the smaller natures of shell) by striking them against the gun-carriage if more convenient; this operation should be performed fairly, and not so as to split or injure the top of the fuze; the fuze must not be uncapped until the shell is placed in the muzzle of the gun. The fuzes for rifled M.L. guns are "uncapped" by taking hold of the small end of the copper band, which is left exposed, and unwinding from left to right smartly, so as to thoroughly detach the band from the head of the fuze and to leave the priming fully exposed.

Fuzes, Percussion, B.L., Plain.—These fuzes are used in the B.L. 20-pr., 12-pr., 9-pr., and 6-pr. segment shells, and in the 20-pr. land service 12-pr. and 9-pr. B.L. common shells ; they require no preparation except the removal of the safety-pin, which is to be taken out just before dropping the fuze into the shell ; care must be taken to insert it properly ; the part with the rim round it is the top of the fuze ; it should be firmly held in its place by the fuze-hole plug, or the E. time-fuze, whichever may be used, being screwed tightly down on to it.

Fuzes, Percussion, Pettman, G.S. and L.S.—These fuzes require no preparation,—they are simply screwed firmly into the fuze-hole by means of the “Key, iron, fuze and plug, G.S.” In the case of certain shells * filled for the Navy, the wad with loop, see § 2370, will be placed over the S.S. fuze.

Fuzes, Percussion, R.L.—These fuzes require no preparation except the removal of the safety-pin,—they are screwed firmly into the fuze-hole by means of the “Key, iron, plug, G.S.”

The safety-pin is *not to be removed* until the shell is placed in the muzzle of the gun. In the case of B.L. shell it must be removed just before loading.

Wad, Papier Mâché, in Fuze-Hole.—When fixing fuzes in shells having a wad in the fuze-hole, or in the bottom of the socket of 20-pr. land service, 12-pr. and 9-pr. B.L. common shells, it is not necessary to remove the wad, as the explosion of the fuze is sufficient to force it into the shell if using percussion fuzes, and if using wood time-fuzes, the wad should be driven into the shell in the operation of fixing the fuze.

EXTRACTING WOOD FUZES.

Fuzes for Rifled Ordnance.—Apply the fuze-extractor to the head of the fuze and unscrew ; if the adapter which is in the fuze-hole of some B.L. shells should also be unscrewed, do not remove the fuze from it by striking it on the end, as a blow in that direction may weaken or break the wire that suspends the hammer in the breech-loading fuze.

Fuze for Common and Diaphragm Shrapnel.—Clear out the cup of the fuze with the projecting piece of metal on the handle of the fuze extractor ; take a firm hold of the head of the fuze between the jaws of the fuze extractor and turn from left to right. The small knob between the jaws fits into the cup of the fuze and prevents the top from collapsing or giving way.

An “Extractor fuze, large,” is supplied for use with 13, 10, and 8 inch mortar shells on demand.

IMPLEMENTS FOR PREPARING AND FIXING LARGE MORTAR FUZES.

One set to every two mortars.

A set contains the following implements, which are to be demanded separately :—

Bits, mortar	-	-	-	-	-	6
Brace, „	-	-	-	-	-	1
Cylinder, wood, mortar	-	-	-	-	-	1
Mallets, mortar	-	-	-	-	-	1
Instructions, printed sheets	-	-	-	-	-	1

Fuzes, Time, Wood, Boxer, Mortar.—Hold the fuze firmly in the left hand ; insert the point of the bit into the required hole ; place the head of the brace against the body and turn with the right hand until

* 20-pr. B.L. common, 40-pr., and 7" B.L. common and segment shell, and common shells for 64-pr. R.M.L. and upwards.

The *G.S. wad*, Mark II., serves to prevent the powder from working up in the fuze-hole of common shell. It is made of papier mâché, and has a hole in the centre covered by shalloon cemented to one side. This wad is forced in by fixing the time-fuze, and does not require removing when the percussion fuze is used. The side covered with shalloon is placed downwards in the shell. Its use is confined to siege, field, and boat service.

Copper scrapers are used in removing powder from filled shell. There are three sizes. They consist of round copper rods, having both ends flattened down. One end is turned up nearly at right angles to the body of the rod, the other end has a slight bend in the opposite direction. Copper scrapers. §§ 2174, 2823.

The largest size is 42 inches long, and is issued for use with 10-inch R.M.L. shells and upwards.

The next size is 32.25 inches long, and is issued for use with 80-pr. R.M.L. to 9" R.M.L., with 7" R.B.L., and with 13" S.B.

The smallest size is 19.9 inches long, and is issued for use with 7-pr. R.M.L. to 64-pr. R.M.L., with all R.B.L. calibres (7" excepted), and with all S.B. calibres, excepting 13".

One miner's powder horn is issued per battery for garrison guns. Powder horns. It contains $1\frac{1}{2}$ lbs. of F.G. powder, and is used for priming guns if § 1125. required.

Wood Bottoms.

Used with shot fired from bronze guns to save the guns, with shot carried with iron guns of position to steady them in the limbers, also used with all shells (except mortar shell, and the 100-pr. naval shell which has a top), and with carcasses except when fired from mortars. They are necessary with shell to keep the fuze, and with carcasses to keep the vents in the proper position. They are shaped so as to fit the pieces of ordnance for which they are intended; thus, they are conical as a general rule, for all the shell guns and howitzers which have gomer chambers, and for all unchambered ordnance of corresponding calibre (the 68, 32, 24, and 12 pr. gun shell would have conical bottoms though the guns have not gomer chambers), hemispherical for the $5\frac{1}{2}$ " and $4\frac{3}{4}$ " howitzers which have cylindrical chambers, and cylindrical for all other ordnance. They are stamped with the nature of ordnance with which they are intended to be used. Carronades have cylindrical chambers, but if shell were required to be used with them any kind of gun or howitzer shell would be used without regard to the shape of its bottom.

They are made of well seasoned elm or alder, or of teak for tropical climates. The grain runs plankways, except for shrapnel up to 24-pr., where the grain runs endways, and the bottom is carried higher up on the shell, and is secured from splitting by a tin strap, this ensures the bottom breaking up, and so there is less risk when firing over troops in front, also the shooting is said to be improved by the bottom quitting the shell readily. Common and shrapnel bottoms.

It is hardly necessary to mention such an unimportant exception to the rule as the $4\frac{3}{4}$ " and $5\frac{1}{2}$ " shrapnel shell, which have the same hemispherical plank bottoms as the common shell, but the $4\frac{3}{4}$ " has the small shrapnel rivet hole.

Bottoms for land and boat service are fastened by a single expanding gun-metal rivet; the rivets are of two sizes, small for shrapnel up to 18-pr. and large for all other shell, and also for shot; these rivets being hollowed out at the base expand into undercut holes in the shell or shot. Rivets.

Naval bottoms. For naval service, to allow of the practice of double shotting, it is found advisable to have the metal of the shell in contact, otherwise they are liable to break up. The single rivet cannot therefore be used, a piece being cut out of the centre of the wood bottom.* The bottom is fastened to these shell by means of two inclined rivets, which are simply cylindrical pins of copper not hollowed out and having no heads. Here the weakness of the 10" gun leads to its having a peculiar form of bottom, it would be dangerous to double shot the gun, so the bottom is not hollowed out, but it might be inconvenient to have a different plan of riveting for the naval service, so the bottom is prepared to take naval rivets, and to avoid having two kinds of bottoms for this gun it is also prepared for the L.S. central rivet.

To fasten on bottoms, No. 2 set garrison is used.

Issue. When not issued fastened to the shell they are strung by 20 on an iron rod for land, and on a wooden rod for sea service; 10 per cent. over the number of shell are allowed.

Tops. Tops were introduced for naval service, they save space in stowage, protect the fuze and facilitate loading, but owing to the introduction of rifled guns they have only been applied to the 100-pr., they are fastened to the shell by four rivets of the same description as are used for naval bottoms.

CHAPTER IV.—PROJECTILES FIRED FROM SMOOTH-BORE ORDNANCE.†

SHOT.—SHELL.—MISCELLANEOUS PROJECTILES.

SHOT.

Service shot.

1. Shot, solid, spherical common.
2. „ case.
3. „ grape.
4. „ sand.

1. Solid shot. 1. *Solid shot* are made of all calibres except the 10", from 3-pr. to 100-pr. inclusive.

It has been mentioned (p. 35) that they are attached to wood bottoms for bronze guns and guns of position, but smooth bore guns having disappeared from the field batteries and batteries of position, shot with wood bottoms are almost obsolete.

§ 2375. Shot are used against masonry, wooden shipping, and masses of men. Hot shot may be considered obsolete, as the furnaces are withdrawn.

* Naval rivets are of two sizes, medium for 100-pr. tops and 32-pr. bottoms, and short for 8" and 10" bottoms.

† The calibres of the S.B. guns are—100-pr. 9", 68-pr. 8-12", 56-pr. 7-65", 42-pr. 6-97", 32 pr. about 6-35", 24-pr. about 5-82", 18-pr. 5-29", 12-pr. 4-62", 9-pr. 4-2", 6-pr. 3-67", 3-pr. 2-913. The windage generally lies between .1 and .2".

All service projectiles are painted black; such as are issued with wood bottoms, together with case, grape shot, and filled mortar shell are packed in boxes, otherwise they are issued loose.

Shot are fired from guns, carronades, and the 12-pr. S.S. bronze howitzer, they are not fired from shell guns 8" and 10".*

Shot bearers for use in painting shot are made in the Royal Laboratory.

Loose for garrison service. Loose, prepared for bottoms for Indian F.S. Issue. Riveted and boxed for F.S.

Steel and chilled iron shot were issued for 100, and 68-pr. guns for use against ironclad ships, but as smooth bores are powerless against the ironclads of the present day, these shot have become obsolete and are to be used as common shot. Steel shot have an S. stamped on them and are painted white. Chilled shot are painted black with a white belt.

Case shot are made of all calibres; they consist of sand shot made up in cylinders and packed in wood shavings or sawdust. 2. Shot, case.

They may be divided into three classes, viz. :—

1. Iron case with iron ends and iron handle on top.

This class includes case for 32-pr. gun, 8-inch gun and howitzer, 68-pr. gun, 10" gun or howitzer, and 100-pr.

2. Tin case with iron bottom and rope, handle on bottom.

This class includes case for all iron ordnance (except $5\frac{1}{2}$ inch howitzer) above 12-pr. not included in class 1, namely, 18-pr. gun and carronade, 24-pr. gun and carronade, 32-pr. carronade, 42-pr. gun and carronade, 56-pr. gun, 68-pr. carronade.

3. Tin case with wooden bottom.

This class includes case for all bronze ordnance, for all iron ordnance below the 12-pr, inclusive, and for the $5\frac{1}{2}$ -inch howitzer (both iron and bronze).

The object of the wood bottom is to guard against injuring the bore of the bronze ordnance, and for the sake of uniformity the same case is used for the iron ordnance of corresponding calibre in the instances mentioned above.

Case for bronze howitzers has H. stencilled in white, an inch and a half long, to distinguish it.

In loading, the rule is always to put the handle away from the charge, except when it is made of rope, when the reverse is the case. The wood bottom goes next the charge.

Case shot are filled with sand shot, which vary in weight from 1 lb. to 8 oz. with heavy guns down to 32-pr., and vary from 8 oz. to 2 oz. with the smaller guns.

Case shot are fired from all natures of guns, howitzers and carronades, Use. against troops in masses, for flanking ditches, &c., and against boats and rigging of ships. They are effective up to 350 yards. Case which have wood bottoms follow the rule laid down as to shape given in page 35.

Case are issued in rough deal boxes with elm ends; the number in a box varies with the calibre of the shot. Issue.

3. *Grape shot* of all calibres from 6-pr. to 10-inch inclusive, is being superseded by case. The pattern at present in use is "Caffin's" pattern. § 1689.

The sand shot are held in position by four iron circular plates pierced with holes to grip the shot, an iron spindle passes through the plates, and a nut which screws on to the head of the spindle binds the plates and shot together.

Carronade grape is to be broken up when returned to Woolwich, it was made up in tin cylinders and painted red. At out-stations it is retained for local issue if serviceable.

* When fired under 3° of elevation, grummet wads are used consisting of rope bent in a circle, and held in position by two cross pieces of small rope. The cross pieces go outside next the rammer head, otherwise the wad may be withdrawn by the rammer. Junk wads are made up of old junk beaten into a solid cylinder and wadded over. They are now only used in conjunction with wooden tampeons for S.B. guns.

The 10" gun has special grape made up in cylinders like case, but has larger balls ; it is known by having G. stencilled on it in white, an inch and a half long.

The sand shot vary in weight from 4 lbs. to 13½ oz. ; it will be seen that they are heavier than the sand shot used for case, and consequently there are fewer of them.

Use.	Grape is used for the same purpose as case ; it is effective at rather longer ranges than case, and would probably be more destructive to boats and rigging. It may be used up to about 600 yards.
Issue.	Made up in boxes, the number in a box varies with the calibre of the shot.
4. Shot, sand. § 1582.	4. <i>Sand shot</i> are cast-iron balls varying in weight from 4 lbs. to 1½ oz. ; their chief use is in the manufacture of case and grape and also shrapnel for the Woolwich rifled guns.
Paint.	Black if used for grape, otherwise unpainted.
Hollow shot.	<i>Hollow shot</i> may still be met with ; no more will be made. They are to be used up at practice, and are known from solid shot of corresponding calibre by their weight.

SHELL.

§§ 1349, 1880, 2204. All shell filled in any arsenal or dockyard have the monogram of the station, the word "filled," and the date of filling stencilled on them, the boxes also would be marked "filled" in red. Shell for field batteries are carried filled in the limbers and wagons.

Classes.	1. Common. 2. Naval. 3. Mortar. 4. Hand grenade. 5. Diaphragm shrapnel.
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1. Common shell. 1. *Common Shell*, gauge, common. *Fuzes, common time and Pettman L.S. percussion. They are fired from guns, howitzers, and carronades, and 5½" and 4½" mortars, and are made of all calibres from 12-pr. to 10" inclusive, except 100-pr., which has naval shell ; they are about ⅙th of their diameter in thickness, and weigh empty about ⅔ the weight of solid shot of the same calibre ; the 10" is ¼th in thickness ; they have wood bottoms in accordance with rule on page 35, and have a fuze-hole of the common gauge tapped throughout so as to take Pettman's L.S. fuze ; the fuze-hole is closed with a gun-metal plug marked with a × to show that the fuze-hole is threaded throughout ; the plug has a shoulder fitting into a recess, a leather washer fits under the shoulder to make the joint tight, the fuze-hole is countersunk, which enables them to be used as shot without bottoms.† Mark II. common plug differs from the previous pattern in having no shoulder, and may be known from the G.S. plug by having a × marked on it.

§ 1603.

The 12-pr. shell has a gun-metal socket fitted into the fuze-hole extending some way into the interior of the shell. Without this the shell failed to burst as the powder was not sufficiently confined, the size of the fuze-hole being large compared to the size of the shell.

Blowing charges. All common shell are completely filled with powder (L.G. shell), see page 28. For practice in places where the full charge might be dangerous, blowing charges are used, 3 oz. up to the 24-pr. inclusive, and 4 oz. for the higher natures ; they are put in loose, except when the small mortar fuze is used with the 12 and 24 pr. shell when fired

* Proportion of fuzes. One common fuze to two common shell and 10 per cent spare ; and one Pettman's L.S. percussion fuze to every two shell.

† Plug, common, with lanyard attached, is issued for drill purposes.

from $4\frac{3}{4}$ " and $5\frac{1}{2}$ " mortars, in which case the charge is placed in a small red shalloon bag, *vide* p. 40.

Full directions for filling shell and securing them are given on p. 28. It may be pointed out that a shell with its plug and wad in it is quite secure against being ignited by an explosion near it;* the wad alone has been found to protect the powder when the plug has been shaken out. It is also to be remarked that the wad does not require removal before inserting the fuze, as the fuze drives it in on being set home; directions for boring and fixing are given on pages 31, 32.

12 and 24 pr. common shell are used with the $4\frac{3}{4}$ " and $5\frac{1}{2}$ " mortars; §§ 1698, 1841. they are to be of small gauge, and it is directed that at out-stations shell for this purpose are to be tried by testing them with the mortars themselves; the common fuze would be used with these shell when fired from mortars except at long ranges, when the small mortar fuze would be used.†

The 10" being a weak gun causes some exceptional arrangement with its shell, thus the gun may not be double shotted; so with 10" naval shell a special bottom is used having two rivet holes, besides the ordinary hole for L.S., in order that it may be attached by either the naval or L.S. method; also its common shell is thinner, as the gun has a light charge; it has no shrapnel, as the weight would strain the gun too much. 10" shell, which weigh over 85 lbs., are to be condemned, and may be converted to mortar shell.

Common shell are used against men in masses, houses, buildings, Use. shipping, and material generally; they may be used either by bursting them in flight, when they act both by the velocity with which the shell is moving and by the force of the bursting charge; but they scatter too much in this way, and are not so effective against men as Shrapnel. They may also be used by bursting the shell when at rest, when they act as a mine; they are most destructive against wooden shipping; they would also be available against men in hollows or sheltered by buildings, where shrapnel would be powerless.

Recovered shell that have been fired at practice may be used again, § 1610. filled with sand only; they should have a red ring round fuze-hole to show that no powder is to be used (recovered mortar shell may be used with blowing charges), and also the yellow line for practice. Recovered 32-pr. naval shell are not to be used because of the pro- § 1778. jecting bush.

Empty, loose, prepared for bottoms for garrison service.‡

Issue.

Filled, riveted, and boxed for field or boat service. When for boat service, issued fuzed with Pettman's L.S. percussion.

Naval Shell.—Calibres, 100-pr., 10", 8", or 68-pr., 32-pr. Gauge, Naval shell. G.S. fuzes, 9 or 20 seconds M.L., and Pettman G.S. percussion.

Naval shell differ from common in having the G.S. gauge (an adapter converts them from the old Moorsom gauge), and in having their bottoms attached by two rivets.

The fuze-hole is closed by G.S. plug, which has no shoulder. The object of having the bottoms hollowed out is to have the iron of the projectile in contact, otherwise they are likely to split when double

* They might, however, explode if struck directly by a projectile or by a piece of a burst shell.

† The proportion of fuzes issued for $5\frac{1}{2}$ " shells is one common fuze to three small mortar fuzes for 4 shell; for $4\frac{3}{4}$ " nine common fuzes, and one small mortar fuze for 10 shell; 10 per cent. to be spare in all cases.

‡ For 10" and 8" guns and howitzers, and 68-pr. gun and carronade, two wood shell boxes are provided to carry the shell up to the gun. (Army Equipment, 1876.)

- shot. The 100-pr. has a top attached in place of a bottom. Space in stowage is saved by this plan, and the fuze is well protected.
- Issue.** Naval shell are generally issued filled, riveted to bottom or top, and fuzed with G.S. percussion fuze; those with bottoms are boxed. For L.S. would be issued empty, prepared for bottoms.*
- The adapter for spherical shell is made of gun-metal, tapped externally to fit the Moorsom gauge, and internally with the G.S. gauge.
- Mortar shell.** *Mortar Shell.*—Calibres, 8", 10", and 13". Gauge, large mortar. Fuze, large mortar.† Fired from 8", 10", and 13" mortars. The fuze-hole is not regularly tapped, but is roughed. The gauge is much larger than the common gauge. The fuze-hole of the 8" is a little smaller than the others, as otherwise the fuze would touch the bottom of the shell before it was fixed in the fuze-hole. Of course this makes the fuze protrude farther. The 10" and 13" shell have lugs; hooks fit into the lugs to enable the shell to be carried. The 13" have the hooks hung by chains from a beam, and are called beam hooks. Hand hooks are used with the 10". In future manufacture the shell would have lewis holes. The holes incline inwards, and the iron plugs at the end of the chains bite into them, when the chain to which the plugs are attached is tight, and can be removed when the chain slackens. The advantage of lewis holes is that there is nothing projecting which is liable to be broken off in piling or transit.
- As these shell require no bottoms they have no rivet holes.
- Issue.** For L.S. they are issued loose, the fuze-hole closed with a beeswaxed cork. This cork may be driven into the 10" and 13", but must be pulled out of the 8", as it might otherwise hinder the fuze from being driven home; a corkscrew is provided for this purpose. For sea service they are issued, filled and boxed. The fuze-hole is closed with a cork and kit plaster. Kit plaster is stout canvas prepared with pitch, tallow, beeswax, and rosin.
- Kit plaster.** To prepare shell, see page 29.
- Blowing charges.** Mortar shell are completely filled for service and sometimes for practice; but for practice, where full charges would be dangerous, blowing charges are used, which are made up in red shalloon bags, narrow at the mouth, and with a brass ring to prevent the bag falling into the shell. They are jammed into the fuze-hole by the fuze.
- 4 oz. used for 8", 10", and 13".
3 oz. used for 5½" and 4¾".
- Use.** Mortar shell are used for vertical fire, and employed for the bombardment of towns, forts, entrenched positions, &c. They may be employed against shipping, but are too inaccurate to give good results on a small object. The 5½" and 4¾" mortars are used against troops under cover. For this purpose the fuze should be bored rather short to ensure the shell bursting before penetrating the earth. On the other hand, the larger shell used against material should have their fuzes bored long.
- Hand grenades.** *Hand Grenades* are of two sizes, 6-pr. and 3-pr. They resemble common shell, but the walls of the shell are not so thick, being about ¼th of the diameter. The fuze-hole is much smaller, and is not roughened. They are generally issued empty, loose, for L.S., and filled and fuzed for S.S., the fuze being covered with a kit plaster. These are boxed.
- Issue.**

* Naval shell may be issued for L.S. (Army Equipment, 1876, p. 72). They would then be issued empty, loose, prepared for bottoms. They, of course, require fuzes of G.S. gauge.

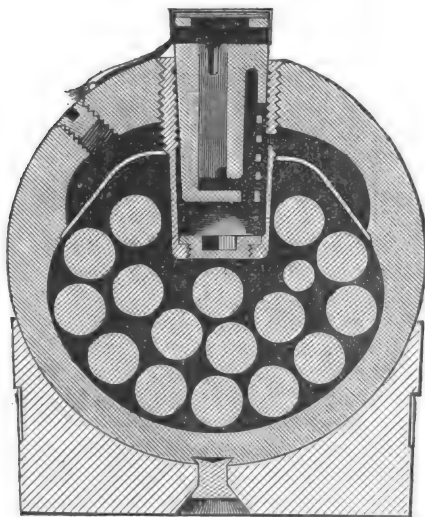
† Proportion of fuzes issued is one per shell and 10 per cent. spare.

They are used chiefly for the defence of places against assault, being Use. thrown among the storming parties in the ditch. They are useful in the defence of houses; they have been fired out of mortars instead of pound shot. They can be thrown by hand about 20 or 30 yards.

Diaphragm Shrapnel Shell.—Gauge, common. Fuze, diaphragm.* Diaphragm shrapnel shell. For all calibres except the 10" and 3-pr. Fired from guns, howitzers, and carronades.

The shell is a thin cast-iron shell (*see cut*), weakened by four grooves down the sides to make it open out easily and uniformly, thickened at the junction of diaphragm and shell, as otherwise it would split into two pieces instead of four or five, as desired; thickened at the fuze-hole to support the socket, and thickened at the base in all natures above 12-pr. to withstand the shock of discharge.

12-pr. Boxer Diaphragm Shrapnel Shell.



A wrought-iron cup or diaphragm divides the shell into two unequal parts, the smaller forming the powder chamber, and the larger being filled with lead and antimony bullets† (lead six parts, antimony one part) packed in coal dust. The antimony hardens the lead and prevents the bullets losing their form by being pressed together.

The diaphragm has a hole in the centre, through which a gun-metal socket passes, which serves to contain the fuze. This socket is not countersunk, as is the case with common shell, but is flush with the surface of the shell. (These shell would not be used as hollow shot so countersinking is not necessary.) Through this socket the bullets are introduced and the bottom of the socket is then screwed in. The socket communicates with the powder chamber by a fire hole. The gun-metal plug which screws into it has a wooden plug covered with serge attached which prevents powder working in and filling up the space for the fuze. The powder chamber is filled with pistol, R.F.G., or F.G. § 2286 and A.C. 7/74.

* Proportion issued is one per shell and 10 per cent. spare.

† Musket balls mixed with pistol, to fill up the intervals, are used with the larger natures of shrapnel, viz., to 18-pr., and carbine balls with the smaller.

As lead is half as heavy again as iron it is much better suited for bullets; sand shot lose their velocity quicker.

powder through the loading-hole. The loading-hole varies in size, being smaller for the lower natures of shell up to 18-pr. inclusive.

The main advantage gained by separating the powder is to avoid premature explosions.

For instructions for preparing shell and fuzes, *see* pages 29, 32.

Use. As a small charge of powder is used merely to open the shell, the effect depends wholly on the velocity with which the shell is moving. The shell should be burst at a distance of 50 to 20 yards in front of the object. It is most destructive when used against columns, but may be used against troops in line. As the quantity of powder which the chamber holds is only just sufficient to open the shell, it is necessary to measure or weigh the charge to ensure the shell having the full amount of powder.

Issue. Empty, loose, prepared for bottoms for India.

Empty, riveted, and boxed generally.

Filled, for field, naval, and boat service, and boxed.

N.B.—Shrapnel are always issued with their balls. Mistakes seem to have arisen from shrapnel being demanded “filled” under the idea that this term referred to balls, whereas it refers to the powder.

Improved shrapnel. *Improved Shrapnel* have long been discontinued but may still possibly be met with at out-stations. They may be recognized by their projecting socket and the large hole in the side of the shell through which the bullets were introduced. They scattered the bullets too much, owing to the position of the powder. They are now obsolete.

MISCELLANEOUS PROJECTILES.*

Carcasses.

Ground light balls.

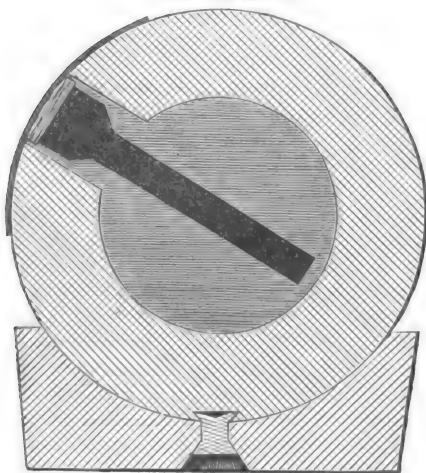
Parachute light balls.

Smoke balls.

Carcasses. *Carcasses.*—Of all calibres from 12-pr. inclusive upwards, except the 100-pr. Fired from all natures of guns, howitzers, carronades, and mortars.

They are shell with three vents (*see* cut) rather thicker than common shell (about $\frac{1}{2}$ diameter) to compensate for the weakness caused by

12-Pr. Carcass.



* Are not now included in equipment, and would only be issued on special demand, showing for what purpose they are required. These stores are specially apt to deteriorate, hence the rule. Manby's shot are now obsolete, and are broken up on return to Woolwich.

the vents. They are a little heavier than common shell of the same calibre. They are filled with composition consisting of—

Saltpetre	-	-	-	6 lbs. 4 oz.
Sulphur	-	-	-	2 „ 8 „
Rosin	-	-	-	1 „ 14 „
Sulphide of antimony	-	-	-	0 „ 10 „
Turpentine	-	-	-	0 „ 10 „
Tallow	-	-	-	0 „ 10 „

This composition is put in hot, and three holes made in it in prolongation of the vents. These holes are driven with fuze composition, and matched with quick match to ensure ignition. The vents are plugged with brown paper and further secured by kit plasters.

Before firing, the plasters and plugs must be removed and the priming exposed. They burn with a violent flame and are difficult to extinguish. Water does not put them out. Earth is the best thing to check their action.

Carcasses have been known to burst.

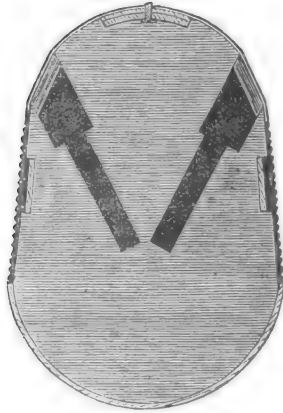
To fire buildings, shipping, &c. Carcasses fired from 13" S.S. mortar and 10" gun are to be fired with charges not exceeding 16 lbs. and 8 lbs. respectively, to avoid straining the pieces with such heavy projectiles.

13" carcasses burn 12 minutes and the others a shorter time down to the 12-pr., which burns 3 minutes.

Carcasses are generally issued filled and boxed, marked as given for shell.

Ground Light Balls.—Calibres 10", 8", 5½", 4½", fired from mortars only. Ground light balls.

4½-in. Ground Light Ball.



They have a wrought-iron skeleton frame (*see cut*), partially covered with canvas, filled with composition, consisting of saltpetre, sulphur, rosin, and linseed oil, which is put in hot, and holes made in it, driven with fuze composition and matched as given above for carcasses.

The body is woolded over with twine. The 8 and 10 inch have five vents in the top; the others have four. The vents are secured with plugs and kit plaster which have to be removed before firing. The 10" and 8" have lugs to facilitate loading.

They are used at night to discover working parties, &c. of the enemy, and might, failing carcasses, be used in their place.

As they are required to remain where they fall, they are only suited to vertical fire.

The composition is not a very good one, but is hard to extinguish, water having no effect on it. A few shovelfulls of earth will hide its light.

Sometimes shell have been placed in light balls to deter men from putting them out, therefore light balls of foreign or doubtful origin should be examined and burned with caution.

Ground light balls weigh from $\frac{1}{2}$ to $\frac{3}{4}$ the weight of common shell of same calibre.

Time of burning varies from 9 to 16 minutes.

They are fired with very reduced charges varying from 2 lbs. to 1 oz.

—				10"	8"	5½"	4¾"
				lbs. oz.	lbs. oz.	lbs. oz.	lbs. oz.
200 yards	-	-	-	0 10	0 4	0 2	0 1
300 "	-	-	-	0 11½	0 6	0 3	0 2
400 "	-	-	-	0 13½	0 8½	0 4½	0 3
500 "	-	-	-	1 0	0 11	0 5½	0 4½
600 "	-	-	-	1 2½	0 14½	0 8½	0 6½
700 "	-	-	-	1 6	1 3	0 12	0 9½
800 "	-	-	-	1 12	1 10	1 0	—
850 "	-	-	-	2 0	1 14	—	—

Issue.

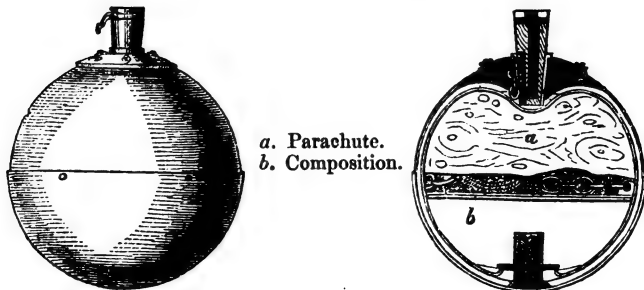
Ground light balls are issued filled and finished and packed in boxes, No. per box varying with nature.

Parachute light ball.

Parachute Light Ball.—Calibres, 10", 8", 5½", fired from mortars. ?

Consists of two outer and two inner tinned iron hemispheres, the two outer are lightly riveted together, the two upper hemispheres are connected by a chain, the inner upper hemisphere has a depression at the top to admit the bursting charge and fuze. A quick-match leader conducts the flash from the bursting charge to the fuze composition in the lower inner hemisphere; the inner upper hemisphere contains the parachute tightly folded up, to ensure its opening, a cord is passed between its folds and through a hole in the top of the parachute and fastened to the upper inner hemisphere, so that when the hemisphere is blown away, the cord is pulled through and the parachute expanded.

Ball, Light, Parachute.

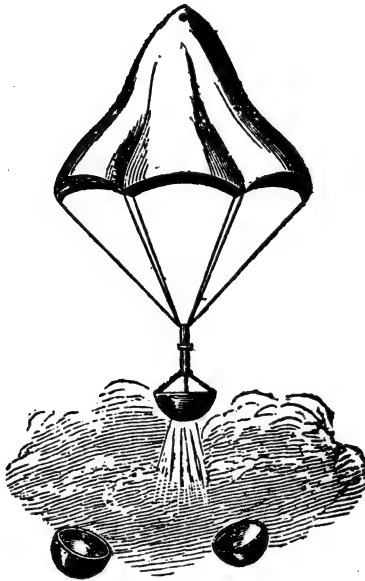


a. Parachute.
b. Composition.

The lower inner hemisphere contains a composition of saltpetre, 7 lbs.; sulphur, 1 lb. 2 oz.; red orpiment, 11 oz. A hole is bored and

driven with fuze composition and matched as usual, this hemisphere is connected with the parachute by cords and chains.

Parachute open after firing.



The bursting charge is issued in the parachute, the fuze is bored to the required length and well hammered in, the parachute placed in the mortar and fired.

The fuze ignites the bursting charge, the outer hemispheres are blown away, and the inner upper hemisphere which is chained to the outer one is blown away with it, the parachute is opened by the cord and expands, the composition in the lower hemisphere being ignited by the quick-match leader which ignites the fuze composition.

The composition burns about 3 minutes in 10'', 1 minute 40 seconds in 8'', 1 minute in 5½''. The 10'' weighs about 30 lbs.; the 8'', 15 lbs., and the 5½'', 6 lbs.

The fuze should be so regulated as to open the parachute just as it begins to descend. No fuze tables have been laid down, but about half the length of fuze should be given which is given to a mortar with similar charge.*

Extreme charge for 10'', 2½ lbs.; range, 1,400 yds.; 8'', 1 lb.; 5½'', 8 oz.

To throw light on the enemy's working parties, &c. at night, it has the advantage of being out of reach, so cannot be extinguished. Careful allowance for wind must be made.

In wooden boxes, one in each.

Issue.

Smoke Balls.—Calibres, 13'', 10'', 8'', 5½'', and 4½'', may be fired out of mortars with very light charges.

* The fuze for a 10'' mortar with a charge of 1 lb. is 1'9'', the time of flight is about 10 seconds. So firing a parachute light ball with 1 lb. charge we should bore the fuze about five seconds; the first number marked on the 10'' parachute fuze is six seconds, so the fuze has to be bored to six.

Construction. A paper shell filled with L.G. powder, saltpetre, coal dust, pitch, and tallow, the vent driven with fuze composition, and matched, and covered with kit plaster, a layer of sulphur and coal dust is sprinkled in three times during filling; in burning, this clears the vent.

These balls appear to be useless as projectiles, they are intended (1) to put in enemy's mines, (2) to conceal operations from the enemy, (3) for signals in the Arctic regions; they burn from one to eight minutes.

It is very doubtful whether smoke balls have ever been fired.

Issue. Filled, finished, and boxed, number per box varying with nature.

Gauges. *Gauges*, high and low, are issued for every kind of S.B. gun, and for stations of inspection; they are simply iron rings with handles, the high gauge should pass over the shot, the low should not.

All S.B. projectiles are below their nominal diameter, while the gun is a little above it, thus an 8" shot or shell has a mean diameter of 7.85".

Windage. *Windage* is necessary not only to allow the shot to load easily, but also to allow for the increased size of the shot caused by rust, &c. With shells windage is useful by allowing the flash of discharge to ignite the fuze.

When shot are repainted it is necessary to scrape off the old paint, which can be done with knives or a piece of an old sword or cutlass.

CHAPTER V.—S.B. CARTRIDGES.

SERGE.—SILK.—CASES FOR HOLDING CARTRIDGES.—POWDER BARRELS.—
S.A. AMMUNITION CASES.

SERGE has been used for cartridges owing to its consuming fairly in the gun and standing travelling well; it is, however, not perfectly safe when fired as blank, because in this case there is not so much pressure and heat as in shotted guns, and the cartridge may not be entirely consumed.

Cartridges are made conical for ordnance with gomer chambers; cylindrical for all others. The cylindrical cartridge is made in one piece, the conical in two; the edges are made to overlap, and are sewed together, which avoids the risk of having three thicknesses of serge under the vent.

Filling cartridges. All cartridges are now filled by weight instead of by measure as formerly. L.G. powder is used. A copper funnel is used in filling them.

They are hooped and choked with worsted; the choke is cut off to 1" for all guns except the 100-pr., which is limited to 3".

Choking. Choking consists in drawing together the mouth of the cartridge into several pleats with a brass needle threaded with three strands of worsted, 3 turns being taken round the pleats; the choke thus formed being further secured by passing the needle 5 times through it, alternately above and below the turns of worsted, thereby stitching down the worsted at 4 points equidistant from one another.

Hooping. Hooping is necessary to preserve the shape of the cartridge; it is done as follows:—In making the last stitch in choking, the needle is turned downwards and carried through the powder and out at the seam, dividing the space between the shoulder and bottom of the cartridge according to the number of hoops required; the worsted is then carried tightly round the cartridge, forming a hoop, which is stitched to the

cartridge at 2 or 3 points in the same way as the turns of worsted at the choke were secured; one, two, or three hoops as required are thus made.

The 100-pr. cartridge is hooped with braid like the cartridge for rifled guns, p. 72.

The diameter of the cartridge is less than the diameter of the bore, to admit of easy loading, and also because the flash would not penetrate so rapidly a cartridge which completely filled the bore; this rapid burning causes the powder to act more violently, as the charge is consumed before the shot has had time to move far, and the more confined the space in which powder is burned the stronger is its action; this consideration shows that a limit is soon reached beyond which elongating the cartridge will diminish the force developed by the powder.

Cartridges are marked in black with the weight of charge and nature of gun; those for howitzers, mortars, and carronades are marked "how.," "mor.," and "carr."

Cartridges for mortars are issued of a size to hold the maximum charge; thus a S.S. mortar, 13", has a 20 lb. cartridge, and also a 16 lb. for carcasses.

The 10 lbs. cartridge for the 65 and 60 cwt. 8" guns, and the 10 lbs. cartridge for the 58 and 56 cwt. 32-pr. gun, are marked D. (distant) to show they are not to be used for lighter guns of these calibres.

Cartridges not filled by the R.A. have the monogram of the station at which they were filled marked on them.

For charges for various guns, and packing, see tables, pages 108, 109, 110, 111.

The following are approximate rules for the ratio of weight of charge to weight of projectile:—*

Shot guns, service charge from $\frac{1}{3}$ to $\frac{1}{4}$ weight of projectile.

Shell guns, $\frac{1}{6}$ th to $\frac{1}{12}$ th.

Carronades, $\frac{1}{12}$ th.

The 5 lbs. charge for the 8" gun is too short for the chamber, and is brought up to length by a wad consisting of coal dust contained in a blue serge bag.

Serge bags are used for containing 10 or 15 lbs. of loose powder or less for filling shell, cartridges, &c.

Cartridges are issued filled to the navy, and empty to the artillery, except for field service, when they are issued either empty or filled according to circumstances. Empty cartridges are made up in bales pressed together by hydraulic pressure, covered with oiled canvas, and outside with stout Hessian stitched together. It may be remarked that the cartridges are not nearly so liable to be attacked by moths as long as the bales are unopened.†

The bales are marked with the nature of cartridge, weight of charge, number of cartridges, and date.

Cartridges, Silk Cloth, are used for blank charges, as they are not so liable to carry fire as serge; they would be used whenever a gun has to be loaded again after firing a blank charge, unless a long interval of time should intervene, as in the case of morning, mid-day, and evening guns; they diminish the risk of firing blank charges. Exercise L.G. is used.

The rule laid down is that silk cartridges are to be used, (1) saluting where the number of guns is less than the number of rounds fired;

* Reduced charges are used when firing at angles of depression; half charge from 15° to 30°; quarter from 30° to 50°, in order not to dismount the pieces.

† The navy carry a certain proportion of empty cartridges, except for boat guns.

(2) where garrison guns are allowed to be fired at reviews by special order ; (3) for exercise in dismissing recruits.

Silk cartridges are at present made up for all S.B. guns, except the 100-pr. and 3-pr.

They are choked and hooped with silk.

Drill car-
tridges.

Drill Cartridges are hollow blocks of wood, covered with raw hide and fitted at one end with an imitation choke and rope handle; they are marked like the service cartridge, which they are intended to represent.

Cases and Barrels for Filled Cartridges and Powder.

As the same case may serve for cartridges for rifled and S.B. guns it will be convenient to enumerate them all here.

1. Metal-lined cases.
2. Pentagon cases.
3. Brass rectangular cases, plain.
4. " " " " corrugated.
5. Gun ammunition barrels.
6. Boxes.
7. Zinc cylinders.
8. Powder barrels.

For capacity of various cases, *see* tables, pages 108 *et seq.*

Luting.

A luting of equal parts of tallow and beeswax is used on the lid to exclude the air as much as possible, and should always be carefully applied before stowing away the cases in magazines.

1. Metal-lined
case.

* *Metal-lined Cases* are of three sizes,—whole, half, and quarter; they are rectangular cases of deal, the corners of oak, and the cleats of ash, lined with tinned copper.

A square lid opens on hinges on top of the case; it is screwed down by two gun-metal bolts by means of a gun-metal key; this lid covers a circular opening which is closed by a bung of tinned copper; the bung is luted into its place when the case is full.

The whole size will take all S.B. cartridges, and rifle cartridges up to 9" inclusive, except those made up with "P." powder; the two smaller sizes are generally used by the navy for small combustible stores, and blank S.A. cartridges.

Metal-lined cases are used in magazines which are not very dry, sailing vessels, and siege trains.

The half and quarter cases hold small-arm cartridges in the following quantities :—

		Martini-Henry.		Snider.	
		Ball.	Blank.	Ball.	Blank.
Half case	-	1,540	2,400	-	1,440
Quarter case	-	660	1,020	-	560
					1,020

§ 2290.

When filled at Woolwich a paper label is pasted across the edge of the lid immediately under the ring, having the packer's name and date of issue. On the side of the case is stencilled the tare and gross weight, the lid is marked with the nature and number of cartridges, the station intended for, and date of their manufacture. Similar information would be given with the other cases.

2. Pentagon
case.

Pentagon Case of 2 sizes, whole and half. The lid hinges on a curved bolt; there are slots in the projecting rim of the lid and corresponding projections on the neck of the case; the lid will only open when the slots and projections are in a corresponding position.

* Bags, calico, metal-lined, or pentagon cases (Mark I.), L.S., § 2431. When powder, not made up in cartridges or bags, is stored in these cases the calico bag will be used.

Suppose the lid to be closed. To open it, first with the spanner unscrew the bolt which presses on the curved bolt, then place the curved projection on the lever into the eye of the curved bolt, the other projection bearing against the lid, and turn from left to right; the lid of the case will then be opened. To close the lid, you turn from right to left.

There is a second socket furnished for the bolt in case the other should get broken. The body and bottom of the case are made of sheet brass, the top and fittings of cast brass.

The whole case takes all S.B. cartridges, and rifled up to 8" inclusive, (charges made up with "P." powder excepted), and also the reduced charges of 15 lbs. for the 9" R.M.L. gun.

The half case is produced by taking a section of the pentagon along a line bisecting the long side of head and perpendicular to it. It has four sides, and is used by the navy for convenience in stowage, generally used for small stores.

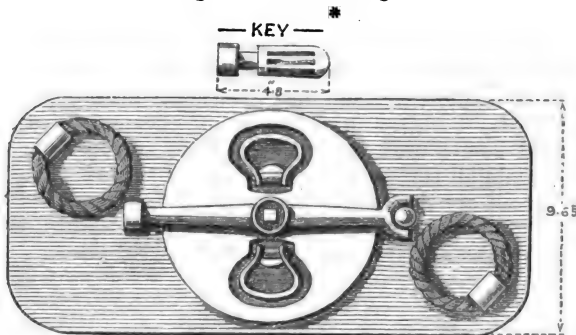
The shape enables the pentagon case to pack well in a ship's magazine. These cases were introduced for naval use.

Brass Rectangular Case is made of sheet brass, cast brass top and fittings. It opens on the same principle as the pentagon. The head working on the curved bolt is a ring in this case. It has two holes which take the projections on the lever. 3. Brass rectangular case. § 975.

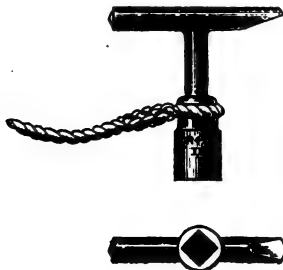
The case will take all S.B. cartridges and rifle cartridges up to 9" inclusive (charges made up with "P." powder excepted). It was specially made for the 100-pr. and 150-pr. No more will be made.

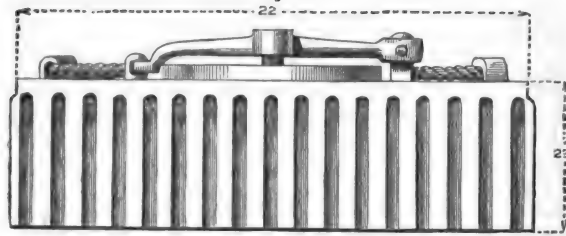
Corrugated Rectangular Brass Case.—Made of corrugated sheet brass, with cast brass top and fittings. The corrugations strengthen the case. They are for S.S. only. 4. Corrugated rectangular brass case.

Powder Case, Corrugated Metal, Rectangular, "A." Mark II.



* Mark II. Key made of gun-metal, with a cross handle bevelled off at one end for the purpose of extracting the ring handles of the lid of the case if they should become fixed in the recess. § 2538.



Side view. $\frac{1}{4}$ th full size.

It is opened by unscrewing the central screw bolt and pulling the bar to one side, thus allowing the lid to be lifted off.

There are six sizes, known as A., B., C., D., E., and F.

§ 1909.

§ 1402.

"A." takes 7", 8", and 9" R.M.L. cartridges. Dimensions, 22" \times 23" \times 10".

§ 1700.

"B." takes 10" R.M.L. cartridges; either two battering, or three full, charges of "P." powder. 26" \times 20" \times 11".

§ 1771.

"C." takes 12" 25-ton R.M.L. cartridges; either two battering, or three full, charges of "P." powder. 22" \times 24" \times 13".

§ 2208.

"D." will take either two battering, or three full, charges of "P." powder for the 12" 35-ton gun. 24" \times 32" \times 13".

§ 2776.

"E." takes two battering, or three full, charges of "P." powder for the 11" R.M.L. gun. Dimensions, 20 $\frac{1}{2}$ " \times 12" \times 28 $\frac{1}{2}$ ".

§ 3061.

"F." takes two battering, or two full, charges of "P²." powder for the 12" 5 R.M.L. gun; or two battering, or three full, charges of "P." powder for the 12" R.M.L. gun of 35 tons. Dimensions, 24 $\frac{1}{2}$ " \times 34 $\frac{1}{2}$ " \times 13 $\frac{1}{2}$ ".*

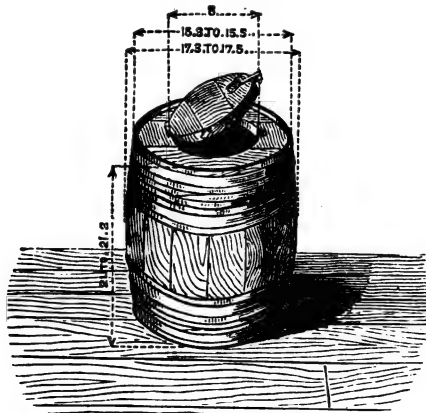
They will take all S.B. cartridges and all the smaller cartridges for rifled guns.

5. Gun ammunition barrel.

§ 774.

Gun Ammunition Barrel.—Of two sizes, whole and half; full bound; four copper hoops; staves of oak, or teak for tropical climates. The lid is generally teak, and has a circular opening, into which a wooden lid fits, working on a hinge and secured by a screw bolt. A gun-metal key is used to screw or unscrew the bolt. The whole size will contain all S.B. cartridges.

These barrels are the same size as powder barrels, but are not intended to contain loose powder. They are used in dry magazines to contain cartridges. No luting is used to close the lid.



* For details as to exact number of cartridges contained in the case, see table, p. 108 et seq.

Ammunition Boxes are used for the issue of cartridges to field batteries at home. They are marked with the nature and number of cartridges.

Zinc Cylinders are used in the L.S. to contain the cartridges of the Woolwich guns. Each cylinder holds one cartridge; the 7-inch, Mark II., will hold two 14 lb. charges, or one battering charge. They not only act as cases in the magazine, but also serve to bring the cartridge up to the gun. Their construction will be understood from the sketch. The 12"-5, the 12", or 11" are not to be stacked more than three deep, the 10" four deep, the 9" and under five deep.

None have yet been sealed for the 8" gun, which was introduced for S.S.

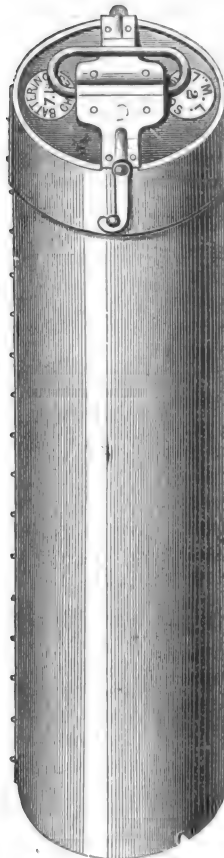
The 9, 10, 11, and 12 inch 25-ton guns have each two cylinders, one for the battering, and one for the full charge; the cylinder for the battering charge of the 12" gun of 25 tons serves for the full charge of the 12" gun of 35 tons. The latter has a cylinder for its battering charge. The 12"-5 gun has a cylinder at present only for the battering charge. Cylinders of recent manufacture will contain either pebble or R.L.G. cartridges.

A hook fastening has replaced the slot, which was not sufficiently strong, and to avoid a difficulty found in opening these latter in the ordinary manner, the latest pattern, Mark II., has the interior of the lid fitted for a felt ring saturated with beeswax,* which is to be inserted when the cylinders are packed with cartridges. Metal straps are to be issued to stations having Mark I. cylinders, with bayonet fastenings. By tightening up the straps by means of screws, one strap to the lid and another to the bottom of the cylinder, a good hold is obtained, and the lid can be twisted round. Zinc cylinders are painted stone colour, inside and out, like brass powder cases.

Powder Barrels used to be "full" bound with twelve ash and four copper hoops.

Machine made barrels are now issued with six ash hoops, they were for some time issued with four, but six are considered to be preferable. The ash hoops protect the barrel by keeping the bilge off the ground, and also keep the copper hoops from slipping. They are of three sizes, whole, half, and quarter, and are used to contain loose powder, and occasionally to hold gun ammunition; they hold respectively 100 lbs., 50 lbs., and 25 lbs. of powder.†

When powder is sent by rail it is put in a flannel bag and placed in a half or quarter barrel. The barrel is covered by a canvas bag and placed in an iron case or cylinder. These iron cases are only made of two sizes, half and quarter; any other combustible stores are sent in the



Scale 2 ins.—1 foot.

6. Ammunition box.

7. Zinc cylinders.
§§ 2171, 2172
2173, 2185,
2270, 2760.

§§ 2437, 2469,
2295.

§ 3042.

§ 2891.

§ 2921.

§ 2173.

§ 2437.

8. Powder barrels.
§§ 1884, 2553.

* If the felt strip is not supplied, tow or wool, saturated with beeswax, is to be used.

† The whole barrel holds 125 lbs. of "P." powder owing to its greater density.

same manner. B.L. small arm cartridges may be sent without being placed in iron cases, as they are very difficult to ignite in any way, and will not explode in mass under any circumstances.

Budge barrels. *Budge Barrels.*—A quarter powder barrel with only one head, the other being replaced by a leather bag, the mouth of which is closed by a leather thong. Used for holding loose powder for mortars.

Small arm cartridge barrels. *Small Arm Cartridge Barrels* are of three sizes, half, quarter, and eighth; they have no copper hoops, and are used for conveyance and storage of S.A. ammunition. The half size is used for blank cartridges, 2,000 rounds (the weight would be inconveniently great with ball cartridge), the quarter size for ball or blank, 700 rounds of Snider or Martini-Henry ball cartridges, or 1,300 rounds of blank, and the eighth for small supplies.

For ball cartridge they are being superseded by boxes, but are still in use for home service.

Boxes, wood, S.A., ammunition. *Boxes, Wood, S.A. Ammunition*, with sliding lid, made of mahogany or teak for foreign service, and of those woods, or of deal, for home service. The following list gives the various patterns :—

§ 1866. Mark I., tin-lined. If iron-nailed, are for “land and home service only;” if with brass screws and copper nails, may be issued to S.S.

§ 1991. Mark II., tin-lined. Brass screws and copper nails, zinc fittings for straps, for “home service.”

§ 1991. Mark III., tin-lined. Tinned iron screws, nails, fittings, and bands, for “land and home service.”

§ 2175. Mark IV., tin-lined. Tinned iron screws, nails, fittings, and bands, for “land and home service.”

§ 2848. Mark V., tin-lined. Brass screws, copper nails, and bands, but no fittings for straps, for “land and sea service.”

Mark VII., tin-lined. Brass screws, tinned iron bands, no fittings for straps, “special for India only.”

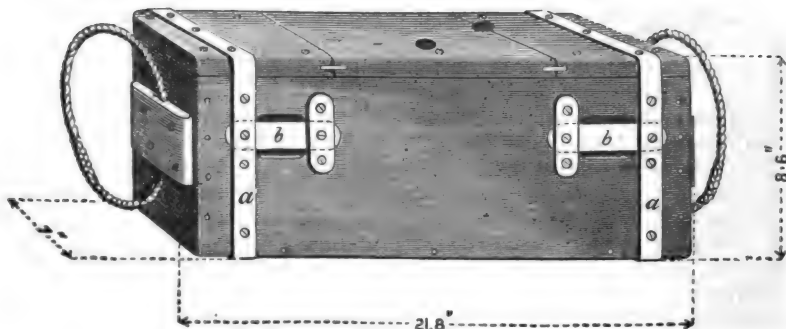
Mark I., not lined. For “home service only.”

§ 2933. Mark VI., not lined. Brass screws, no bands or fittings for straps, for “home service only.”

No new boxes of Marks I., II., III., or IV. will be manufactured in future.

Mark I. box contains 420 rounds of Snider, or 480 rounds of Martini-Henry ball cartridge.

The other patterns contain 560 rounds of Snider, or 600 rounds of Martini-Henry ball cartridge.



The cut represents Mark IV. box. The strap fittings *b, b*, are omitted in the later patterns.

Camel box.

Camel boxes for India hold 2,400 rounds Snider, or 2,600 Martini-Henry ball cartridges.

Bullock boxes for India, 780 rounds Snider, or 840 Martini-Henry ball cartridges. Bullock box. § 1990.

Box, Wood, S.A. Ammunition, Mark II., for Adams' pistol, lined with tin, holds 600 rounds.

Cylinders, Iron, for conveyance of ammunition by rail are cylindrical in form. There are two sizes, to hold half and quarter powder or ammunition barrels. Cylinders, iron.

Bags for Cylinders :—

(a.) Canvas to contain the barrel.

Bags for cylinders.

(b.) Flannel to contain the powder.

All cannon cartridges which are not contained in metal or metal-lined cases, or which are intended for field or siege service, are placed in brown paper bags, the barrel or box in which they are packed being also lined with brown paper. In field batteries the bag would to some extent preserve the cartridge from wearing out; they are also stated to preserve the cartridge from damp. Bags for cannon cartridges. § 1874.

Waterproof bags may be specially demanded; they are made of two thicknesses of fine white paper cemented together by india-rubber dissolved in naphtha.

Waterproof covers for cartridges for R.M.L. guns of 7" and upwards are provided for the navy; they are bags of fine cambric, waterproofed by vulcanized india-rubber attached on one side (not made in department). § 2048. § 2439.

As shell are now ordered to be completely filled, bursters do not require to be made up. As before stated, shrapnel are filled by measure or weight to ensure their having the full charge, as less would fail to open the shell. Shell issued to field batteries would be issued empty, except in first equipments. Bursters made up in paper bags enclosed in calico are, however, still retained for S.B. field batteries; this applies to 6-pr., 9-pr., 12-pr., 18-pr., and 24-pr. diaphragm shrapnel shell. §§ 954, 1581, 1686.

"Gauges, filled Cartridge, Brass Ring."—Are made of 13 different sizes. The gauge is a gun-metal ring with a handle, on which is stamped nature and size. They are used in the examination and making up of filled cartridges, over which they should pass freely. Gauges, filled cartridge. § 1695.

Leather Cases for Cartridges are of ten sizes, viz. :—*

Leather cases.

No. 1. For 13" L.S. mortar, 10" S.B. gun, howitzer, or mortar.

No. 2. For 7" R.B.L., and 68, 56, or 42 pr. S.B. guns.

No. 3. For 8" S.B. gun.

No. 4. For 80 and 64 pr. M.L. or 40-pr. R.B.L. land service, and 32-pr., 63 to 56 cwt., S.B.

No. 5. For 32-pr., 50 to 39 cwt., 24-pr., 50 or 48 cwt., and 8" howitzer, 40-pr. and 20-pr. R.B.L.

No. 6. For 32-pr., 32 or 25 cwt., 24-pr., 20 cwt., guns, 8, 5½, and 4½" mortars, and all carronades, and all smaller natures.

No. 7. For 13" S.S. mortar, or 100-pr. S.B. gun.

A. For 7" R.M.L. guns, S.S.

B. " 8" " "

C. " 9" " "

The case is a leather cylinder with lid, which slides up the handle, and is used to bring cartridges up to the gun from the magazine; it is not uncovered till the sponge is out of the bore.

Heading and Unheading Powder Barrels.—The top end is known by having the staves bevelled off to facilitate heading. See page 126. Heading and unheading powder barrels.

The top is placed uppermost and the top hoops removed, those on the quarter loosened; the left hand is placed on the centre of the head, Unheading.

* Cases are not required in the L.S. for 7" R.M.L. guns and upwards, as the cartridges are brought to the gun in zinc cylinders. Cases of Clarkson's material are used in the S.S. for 7" R.M.L. and upwards. §§ 1798, 2076, &c.

which is struck gently with the mallet close to the edge on the side next the workman until it is started out of the grooves and falls into the barrel.

Should this method fail the head may be "boxed out," the hoops being removed, and the left hand placed on the head as before, a few smart blows of the mallet are struck on the staves, about the middle of the barrel, causing the top of the staves to spring back and the head to fall in as before.

Heading.

Heading Barrels.—The head is placed with its bevelled edge (on the side away from the workman) in the groove, the left hand is then placed on it, and the head is lightly struck with the mallet as much as possible in the direction away from the workman; in this manner it is driven into the groove all round, and the hoops are replaced. If the head should be driven a little beyond the groove it may generally be shaken back into its place by laying the barrel on its side and tapping the end of the staves.

Leather hides.

Leather Hides are used to cover the floors of magazines, wadmill-tilts are also used for the same purpose, in order to diminish accidents from grit or sand. Cloths, hair, are provided in revised equipment.

N.B.—It may be mentioned here that no one is allowed to enter a magazine without putting on leather slippers, which are kept for the purpose.

When men are employed in magazines they should be made, when other circumstances permit, to change their clothes on entering them, to avoid risk from their having matches, &c. in their possession.

Cage, metal.¹
§§ 2218, 2799.

Cage, Metal, Lifting Cylinders.—These are of two sizes. They are made of gun metal, and are used for hoisting zinc cylinders containing cartridges up the powder lifts of magazines. The smaller size, stamped "A.," is for cylinders for 12" of 25 tons and under; it weighs about 14½ lbs. The larger size is for cylinders for 12" of 35 tons and 12"·5 guns, is stamped "B.," and weighs about 17 lbs. 14 oz.

§ 2475.

Mark II. of "A." cage has the top band made broader and carried inwards to prevent jamming when being hoisted up the lift of a magazine.

§ 2548.

A 2" white rope, about 30 feet long, with a hook at one end and a counterweight ball of 1½ lbs. above the hook, is approved for use with the above.

CHAPTER VI.—TUBES.—PORTFIRES.—QUICK AND SLOW MATCH.—SIGNAL LIGHTS, &c.

Tubes, copper, friction.

* FRICTION tubes of copper about 2" diameter are used for firing guns in the L.S.

§ 2049.

§ 2443.

There are three sizes, viz., the short friction tube about 3" in length for guns in general, a special tube about 2" long for the 7-pr., and the long friction tube about 5" long for 7" R.M.L.† guns and upwards in L.S. There is a special 5" tube, with a wire attached to keep it from flying, issued for all the Woolwich guns in the navy when waterproof cartridges are used with guns on main-decks or in turrets; a small lanyard is hooked on to the wire and hitched on to the gun carriage.

The friction tube consists of a copper tube (since 1867 lacquered inside to prevent the powder and metal from acting on each other)

* Proportion issued—one per round and 10 per cent. spare.

† The short friction tube might be used with 7" R.M.L. guns and upwards, when the long are not available, but an occasional misfire may take place.

driven with mealed powder and pierced with a central hole (*vide cut*), the top stopped with shellac putty and the bottom with a disc of varnished paper; a hole is bored through near the top of the tube, and at right angles to it, and over this hole is secured a cylinder or "nib-piece," containing a copper friction bar, roughened, and slightly turned up at one end. The roughened portion of the bar has detonating composition of chlorate of potash, sulphur, and sulphide of antimony smeared on both sides of it; the nib-piece is pinched down so as to press on the friction bar, the projecting part of which has a slightly turned up eye into which the hook of the lanyard fits. The exterior of the tube is painted with black varnish.



On pulling the lanyard (which should be stretched and then sharply Action. pulled) the friction bar is pulled out, igniting the composition and firing the tube.

The central hole in the tube is important, it gives passage for the flash, and causes the tube to act instantaneously, without it the mealed powder would burn like a squib and fail to ignite the cartridge.

Friction tubes are issued in tin cylinders, containing 25.* Each tube is placed in a loop formed by a corrugated strip of tin running round the side of cylinder; the cylinder is closed by a strip of tin soldered on. Zinc cylinders holding 100 or 50, and secured by a varnished band of tape, are also used, but no more zinc cylinders will be made.

Issue.
§§ 1810, 1871,
2055, 2217.

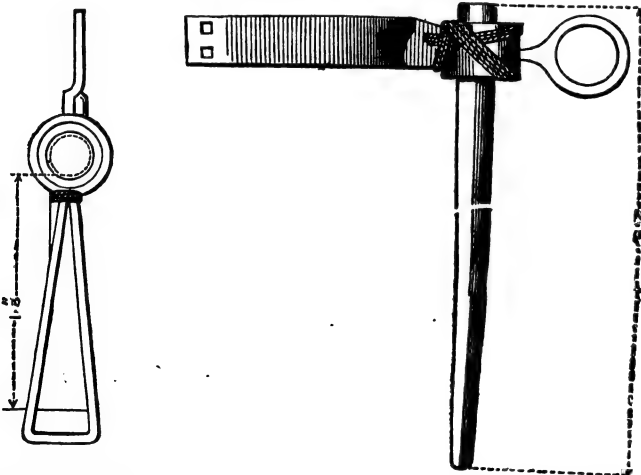
N.B.—Friction tubes are on no account to be placed in a magazine.

For garrison service, a tin tube box 4" × 4" × 3" with strap is used for serving the gun, it contains 100 tubes. A leather tube pocket and strap is used for field service. A Mark II. box is issued, which takes the long tube.

Quill Friction Tubes of two sizes, about 2½" and 4" long, are used by the navy. The general principle of construction is the same; a little

Quill friction
tubes.
§§ 1148, 1618,
2192, 2785.

Quill Friction Tube, Mark II.



mealed powder and ground glass is added to the detonating composition, which is put on one side only of the friction bar; the bar passes through

* Four cylinders, containing 100 tubes, are packed in a wooden box.

§ 1856. the tube. To support the tube when the lanyard is pulled, a leather loop is attached which fastens on to a crutch or pin screwed into the gun near the vent.

The short tube is for use with all S.B. and R.B.L. ordnance, and with R.M.L. guns under the 10" calibre, except when firing reduced charges with 9" and 8" R.M.L. guns.

The long tube, which consists of two of the short quills cemented together, is for use with 10" R.M.L. guns and upwards, with reduced charges for 9" and 8" R.M.L. guns, and for the 24-pr. Hale's rocket. As mentioned above, the special 5" tube is used with waterproof cartridges.

Issue. In tin cylinders, 25 in each.

These tubes could be made available for L.S. on an emergency by fitting up a crutch on the gun.

Lanyards. Friction tubes are fired by means of lanyards. They differ chiefly in length. Those for the navy are made of white instead of tarred line, and have a loop to allow of "half cocking," and a wooden toggle at the end.

§ 2722. The following is the present nomenclature, &c. of lanyards:—

				Length.		
Lanyards, friction tube,	{	field and siege -	- - - -	5' 4"		
		garrison {	plain (a) -	- - - -	12' 0"	
	with loop (b)* -		- - - -	12' 0"		
	{	naval {	Turret vessels -	- - - -	18' 0"	
			long {	64-pr. and upwards -	- - - -	9' 6"
				64-pr. converted (c) -	- - - -	8' 6"
			short -	- - - -	8' 4"	
	rocket machine with block and pulley	- - - -	2' 4"			

Line with loop for garrison lanyards (d).

Common quill tube.

Common Quill Tube, about 3' long, can hardly be considered a service tube; it is used when the gun is fired by a portfire. It would be easily manufactured on an emergency. The point of the quill is cut off and a head is formed by slitting the top into 7 prongs and passing a piece of worsted alternately over and under each prong, so as to form a small cup about $\frac{1}{2}$ inch in diameter. The tube is driven with mealed powder, damped with methylated spirits, and a hole pierced by a wire, the cup filled with a priming of mealed powder, gum and water, made into paste, and sprinkled on the top with dry mealed powder. A paper cap is twisted on to the head of the tube, and the wire passed up again after capping to ensure the hole not being choked up. They require to be uncapped before firing.

Match or Fynmore's tubes.

Match or Fynmore's Tubes, have been used as primers for B.L. guns. They are the same as common quill tubes, having in addition 8 strands of worsted covered with a paste made of mealed powder, gum arabic, and methylated spirits fastened to the cup.

Paper tube.

Paper Tube, about 2 $\frac{1}{2}$ ' long. A strip of paper rolled into a cylinder of .2" diameter; on to the top of the tube another piece of paper is rolled spirally, so as to make a cup. The tube is driven with mealed powder, damped with methylated spirits, and pierced, and the cup filled

(a) For every smooth-bore garrison gun and for all rifled garrison guns under 7-inch.

(b) For all rifled guns, 7-inch and upwards.

(c) For the 64-pr. M.L. gun converted, 71 cwt. See § 2609.

(d) For fitting to plain garrison lanyards when required for 7-inch guns and upwards (§ 2697). Loop to be 18" from the hook (§ 2821).

* The loop is slipped over the centre hind sight to prevent the hook from flying back when the gun is fired.

with priming of meal powder and water. The tube is capped by a piece of paper soaked in saltpetre and water, and tied on by silk. After capping, a wire is passed up to ensure the hole not being choked. The cap need not be removed before firing. This tube is not a service one, but might be made on an emergency to be used with portfires.

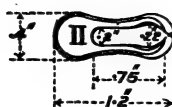
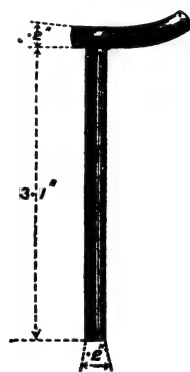
Coated with black varnish; shellac dissolved in methylated spirits would answer.

Abel's Electric Tube.—Two fine copper wires pass down through the head, covered with gutta percha, except very small pieces at the ends. These uncovered pieces are fixed at a distance of $\frac{1}{16}$ " from one another, and the space between them filled with a composition of sub-phosphide and sub-sulphide of copper and chlorate of potash; the other ends of the two wires are bent back and brought in contact with the copper lining of two holes passing through the head of the tube. When the wires of a battery are inserted in these holes, the current passes through the wires and the composition between them, igniting the composition in its passage. The quill tube attached to the head is driven and pierced as usual. Any kind of electricity will ignite these tubes. They are used for proof of guns, firing time-guns by electricity, &c. A magnetic exploder is the handiest way of igniting these tubes for L.S.

In tin cylinders containing 25 each.

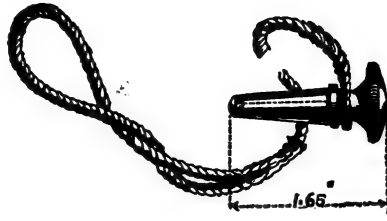
Dummy Steel Friction Tube, Mark I, issued for drill, consists of a steel pin, which fits the vent, having a prong in the head, into which a V-shaped spring fits, representing the friction bar. The lanyard is spliced on to the spring, which can be drawn through the prong.

Mark II. dummy tube has the head formed of two spring clips, which represent the eye of the friction bar of the service tube, so that ordinary service lanyards can be used with it. The strength of the clips is so adjusted that it requires a pull about equal to that necessary to fire a service tube to draw the hook of the lanyard between them.



A Vent Server has been issued for L.S. only at present. It is used in lieu of the thumb, to serve the vents of 64-pr. R.M.L. guns and upwards. It is made of brass with a gun metal head, the part

which enters the vent being covered with a conical piece of leather. A lanyard of various lengths, according to the nature of the gun, connects the vent server with the gun.



Apparatus for
proof of tubes.
§§ 2031, 2101,
2296, 3023.
Common port-
fire.

Apparatus for the proof of tubes are issued to inspectors of warlike stores, and directions are issued with the stands. See Appendix, p. 125.

* *The Common Portfire* consists of a cylinder 16" long, and rather more than half inch in diameter, made of stout paper pasted, rolled up,† and when dry turned in at one end to form a bottom. The empty case or cylinder is supported in a mould and driven with portfire composition, consisting of saltpetre 6 lbs., sulphur 2 lbs., mealed powder 1 lb. 4 oz.

The top has a small hole bored in the composition, and is primed with mealed powder to make it light easily; the exposed end is secured by a paper cap, tied on with twine. They burn from 12 to 15 minutes, and are generally lighted by slow match.

Issue.

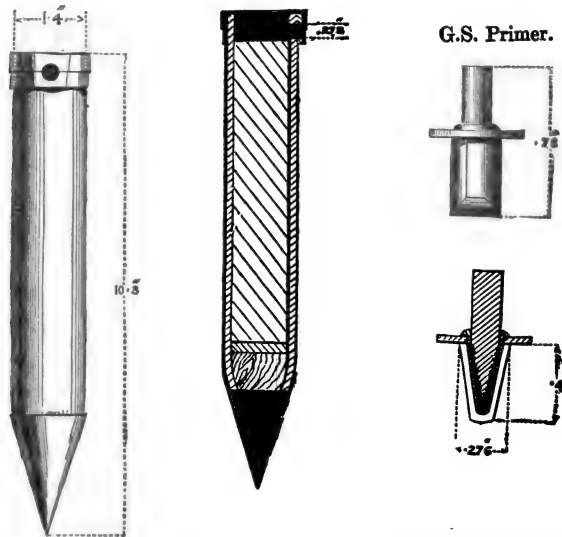
In bundles of 12, packed in deal boxes.

Life buoy port-
fire.

Life Buoy Portfire, burns about 20 minutes; they are ignited by a quill friction tube, which is so arranged that on pulling the trigger to release the buoy, the tube is fired and the portfire ignited.

Lights.
§ 2217.

Lights.—All lights are issued in tin cylinders holding four. The top of the case is marked with the nature of the light and the number contained.



* Issued in the proportion of four per 100 rounds.

† The case is rolled on a steel former, but any smooth cylindrical stick would do.

Coast Guard Light, Mark I., has superseded the coast guard portfire ; Coast guard it burns about five minutes. The spike at the end is to enable the light to be struck in the ground, as a man holding it might be fired at by § 1724. smugglers. The composition is saltpetre 7 lbs., sulphur 1 lb. 12 oz., red orpiment 9 oz. The cap of this light need not be removed before lighting. The top of the composition is primed with mealed powder and the flash blows off the cap. The light is ignited by placing a G.S. primer in the hole in the head marked with a black dot, the wedge-shaped paper covered part of the primer is inserted and the pin projects ; a sharp blow struck with this pin on any hard substance ignites the light. G.S. primer. § 1725.

The primer (*see cut*) is made on a similar plan to the head of the copper friction tube, the pin is roughed and coated with the friction tube composition, and the blow driving it through the wedge-shaped copper case explodes it. The case is open at one end and protected by varnished paper. Primers are issued in tin boxes holding 5, 10, or 15.

Light, Long, G.S., burns about five minutes, ignited by G.S. primer as described with coast guard light, it has about $6\frac{1}{2}$ " of the same composition. A hollow wooden handle with a screw at the end holds eight primers, the handle fits into the projecting socket of the light and is fastened by a wooden pin which is tied on to the handle. Light, long, G.S. § 1721.

They are used for signalling and illuminating both in L.S. and S.S.

Light, Signal, Magnesium, burns one minute with a very brilliant white flame ; its method of ignition, &c. is the same as described with the coast guard and long light, it has about $2\frac{1}{4}$ inches of composition, containing saltpetre 14 lbs., sulphur $3\frac{1}{2}$ lbs., red orpiment 1 lb., magnesium containing 25 per cent. of paraffin, $\frac{1}{2}$ lb. The handle is the same as that for the long light. They are used for signalling or illuminating. Light, signal, magnesium. § 1723.

The older patterns of lights burned about the same time, they were ignited by placing a percussion cap on the nipple and striking against anything hard.

Light for illuminating Wrecks (used with life-saving rocket), contains same composition as coast guard light, is 29" long, and burns nearly half an hour.

Quick Match.—Is made of cotton wick boiled with a solution of mealed powder and gum in about the following proportions, 2 lbs. wick, 20 lbs. mealed powder,* 9 oz. gum arabic, 9 pints of water. Quick match.

Unenclosed it burns at the rate of about 1 yard in 13 seconds ; when enclosed in a tube of any kind it burns much more rapidly, being as instantaneous as a train of gunpowder, the pressure causing the gas to rush forward and fire the mass explosively. Quick match is made up in paper or calico tubes when this rapid action is required, and when so made up is termed a "leader."

The proportions of powder, &c. will vary with the number of threads in the wick, those given above are for six-thread wick. Quick match is demanded by weight, 1 lb. of six-thread match would be about 360 feet long. Quick match is largely used for priming fuzes, &c.

Either in long packing or in metal-lined cases, and should be demanded by weight. Issue.

Slow Match.—Is made of pure hemp slightly twisted and boiled in a ley of water and wood ashes in the proportion of water, 50 gallons, wood ashes, one bushel ; this serves for 100 lb. of yarn. It burns at the rate of one yard in eight hours, it is used for lighting portfires, &c. Slow match may be equally well made by boiling in a solution of 8 oz. saltpetre to one gallon of water. Slow match.

* A portion of the powder is kept dry and dusted over the quick match.

- Issue.** Loose in skeins or parts of skeins placed in a case with other stores. When large quantities are demanded it is issued in bales or casks. It should be demanded by weight ; about four yards goes to 1 lb.
- Bickford's patent fuzes.** *Bickford's Patent Fuzes* burn at the rate of about one yard in 70 seconds, they are made of flax with a column of fine gunpowder in the middle. There are about nine kinds, which vary in the amount of protection given to the flax according as it is wanted to burn in the air, dry or damp ground, or water. A portfire is the readiest way of igniting this fuze.*
- § 2438.** In tin cases containing 8 fathoms.
- Issue.** *Ord's Mining Hose* has quick match protected by paper and calico cemented together with solution of india-rubber and coated by plaited cotton yarn. It is used for firing mines and acts as a waterproof leader, having instantaneous action.
- Ord's mining hose.**
- § 2619.** In lengths as required packed in a zinc or tin cylinder or any suitable case.
- Issue.**

* The gutta percha covered fuzes must have the gutta percha removed and the powder laid bare where the fuze is placed in contact with the charge, the same must be done at the end which is to be lit by the portfire.

CHAPTER VII. — GENERAL REMARKS ON AMMUNITION FOR RIFLED ORDNANCE, ARMSTRONG B.L. SYSTEM, AND B.L. PROJECTILES.

BEFORE entering into the details of the various ammunition for the different systems of rifling, it may be well to call attention to a few points which are common to all.

It has been found necessary to protect the bursting charges of powder against the risk of premature explosions arising from the rotation of the shell, either by lacquering the interior of the shell or by placing the powder in a separate case or bag. Red lacquer is now used, but some shell may be found with black lacquer.*

Lacquering has not been found a sufficient protection to the powder in R.M.L. Palliser and common shell of 7" calibre and upwards; to prevent prematures it is necessary to use serge bags. For instructions for use of these bags in filling shell see p. 30.

The bursting charges of common, garrison segment, and Palliser shell and Palliser shot, when used as a shell, follow the same rule as those for spherical shell, *i.e.* the shell are completely filled with powder. Shrapnel bursters are to be weighed or measured to ensure their having enough powder. Segment bursters are loosely filled with shell F.G. powder for field service shell. § 1580.

When rifled common shell are fired at practice as blind shell the gun-metal plug is to be removed and returned to store, a wooden plug, supplied on demand, being substituted for it. The shell is to be *filled* with a mixture of sand and sawdust, or any similar material available, to make an equivalent weight to the bursting charge. Shell so issued from Woolwich are stencilled "Sand" in white, and are marked with a yellow band.

Shrapnel shell can always be recognised by their flush or projecting bush or socket of gun metal. They are not to be placed on their bases when stored in the open air, as water has been found to enter the shell.

To ensure good shooting, the projectiles should at least be 2 calibres in length, the length of the projectile will be limited by the twist of the rifling; thus we find that the 12" 25-ton gun, which has an exceptionally slow twist, is unable to fire as long projectiles as the other Woolwich guns, consequently its common and shrapnel shell cannot be brought up to the weight of its Palliser projectiles.

It is desirable that all projectiles for the same gun should approximate to the same weight, as otherwise range tables would vary with the different projectiles when the same charges are used.

Cl. 95, Army
Cir. June 1872.

Length of projectile.

* The black lacquer was discontinued as it was found to cause prematures. Vol. III., Proceedings of O.S.C., pp. 143, 240.

Case shot : Case shot for all rifled guns under 7" inclusive is to weigh about $\frac{3}{4}$ the service projectile. For guns over 7", case is to weigh the same as a spherical shot of the same calibre, one or two may be used according to distance. In loading case, the iron handle is to be away from the charge.

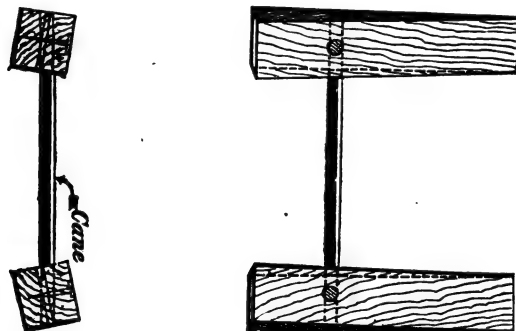
§§ 1754, 2426. All rifled common shell of 64 lbs. and upwards made between March 1869 and February 1873 have unloading holes, closed with gun-metal plugs and papier mâché wads in the head. These holes are used in unloading the shell when it is found difficult to extract the percussion fuze. Experience has shown that the unloading hole was very rarely of use, and to simplify manufacture it has been discontinued. If there is any difficulty in extracting the fuze, the shell may be fired from a gun, or thrown into the sea, or otherwise safely disposed of.

§§ 1346, 2370, 2418. The fuze holes of common and segment shells for 40-pr. and 7" B.L. guns, also for the 20-pr. common shell for S.S., are countersunk about $\frac{1}{2}$ ", so as to protect the Pettman G.S. percussion fuze when the shells are filled and fuzed. In the S.S. the naval wad with loop is placed over the fuze and fills up the countersink. If the shell is empty, a blue wad is placed in the recess to prevent the plug corroding. The same remark applies to all R.M.L. common shell above the 40-pr.

All projectiles for rifled guns are painted black.* The heads, however, of the field service shrapnel are painted red, and the tips of the Palliser shell are painted white. The lead coating of B.L. projectiles is left unpainted.

§ 1973. Grummet wads. Grummet wads are supplied on special demand for use when firing rifled projectiles at angles of depression.

Wedge wads. Two sizes of wedge wads are issued. They both consist of two wooden wedges connected by a piece of cane, as shown in the cut.



In the larger wad the length of cane is 7" $\frac{1}{2}$, and length of wedge 7". It is for use with 9-inch guns and upwards.

In the smaller wad the length of cane is 6" $\frac{1}{2}$, and the wedge 5" $\frac{1}{2}$ long. It is for use for 64-pr., 80-pr., 7", and 8" guns.

These wads are to be rammed home separately after the projectiles. Their use is to prevent the projectile from shifting when running the gun up.

* The 40-pr. R.M.L. shrapnel has its head painted red.

Brass or copper gas checks will probably be soon introduced for Gas checks. R.M.L. ordnance. Some of Major Lyon's pattern have been issued, but the service pattern is not yet decided.

At practice when it is not desired to burst the shells, blowing charges § 2099. are to be used,—7", 6 oz.; 80-pr. and 64-pr., 4 oz.

A calico bag made with a neck to fit the fuze-hole will be used, the shell is first to be filled with dry coal dust, leaving a space for the blowing charge; the bag will be inserted and filled with the proper charge of powder, and the wooden time-fuze will then be driven firmly into the fuze-hole.

As the shot from rifled guns always strikes point first the arrangement of percussion fuzes is much simplified; even the ordinary time-fuze will act percussively if the shell strikes a solid obstacle. The arrangement of shrapnel shell is improved, the powder chamber being placed behind the balls. The best form* and material of head can be used for the special purpose for which the shell may be intended; thus in the Palliser projectiles the head is much harder than the body, the latter having greater tenacity. All projectiles, hollow or solid, can be brought to the same weight for the same gun, or if wished, specially heavy projectiles can be used.

In all ammunition for rifled guns the pattern or mark is shown by a §§ 1126, 1162, Roman numeral; this is *important*, as by quoting the numeral the 1545. nature of store in a fort or field battery can be identified.

Armstrong B.L. System.

This was the first method of rifling introduced into the service. There is no windage, and therefore a percussion arrangement is required for igniting the fuze, but there is the great advantage of the gun being preserved from "guttering," *i.e.*, the destructive action of the gas rushing over the projectile. The projectile is lead coated, and is slightly larger than the bore of the gun; it is placed in a chamber at the breech, large enough to admit it freely; the gun is polygrooved, and the force of the explosion compresses the lead coating into the grooves, a pressure of many tons is required to do this, and the lead coating requires to be very firmly attached to the projectile. The coating consists of lead and antimony in the proportion of 19 lead and 1 antimony. This does not combine with iron, and therefore it is found necessary to dip the shell first into a bath of zinc, then into one of lead and tin, and lastly to pour upon it the final coat of lead and antimony.† Occasionally blisters appear on the coat, these ought to be pricked and hammered down. Any shell that have their coating loose can be detected by tapping them with a hammer.

The early patterns of Armstrong garrison shell had the Moorsom G.S. adapter. gauge, but all that are required for use are converted to the G.S. gauge § 1427. by means of the G.S. adapter (rifle), a gun-metal socket, which is permanently screwed into the shell; the adapter differs from that used for spherical shell in being longer.

* The ogival form of head has been found the best, both for overcoming the resistance of the air and for penetrating armour plates. The heads of all Woolwich projectiles of recent manufacture, except shrapnel, are struck with a radius of $1\frac{1}{2}$ calibres, for example, the head of a 10" projectile would be struck with a radius of 15". Shrapnel are generally struck with a radius of 1 calibre.

† The segment shell is placed in a lead and antimony bath after the zinc bath, to avoid using the expensive bath of lead and tin, to fill up the interstices among the segments.

Gauges.
§ 1314.

A high ring gauge which passes completely over the body, and a low ring gauge for back end which only passes over just behind the cannellure, are issued to stations of inspection; for service the high gauge is the important one, and is issued to field batteries and for garrison service; the shell should occasionally be tested by passing the high gauge over them to see that the lead has not been set up by travelling in the limbers. If it is too large it can be filed down.

The calibres of Armstrong B.L. guns are,—

7-inch	-	-	-	7 inch.
40 "	-	-	-	4.75 "
20 "	-	-	-	3.75 "
12 "	-	-	-	3 "
9 "	-	-	-	3 "
6 "	-	-	-	2.5 "

The shell are about .07" or .08" larger in diameter at their base than the bore of the gun.* All the projectiles for the same gun approximate to the same weight.

B.L. Projectiles.

- | | |
|-------------------|---------------|
| 1. Segment shell. | 4. Case shot. |
| 2. Shrapnel " | 5. Solid " |
| 3. Common " | |

1. Segment
shell.

Segment Shell are of two classes—garrison and field.

The shell is of thin cast iron, cylindro-conoidal in shape, cast without a base and weakened by four grooves in the head. It is weakened by grooves in the body. Segments of cast iron are built up in layers on a cast-iron disc, having a hollow space in the centre; these segments are introduced into the shell, forming an interior lining to it; the lead and antimony in the operation of coating is allowed to flow into the shell through a hole near the shoulder (the powder chamber being closed by a core or mandril); the lead flows between the segments, binding them together; the base is also fastened on to the body by the lead coating, which seals the joint between base and body; this construction is very strong against external pressure, but opens readily when acted on by the bursting charge.

Garrison seg-
ment shell.

Garrison Segment Shell, 7", and 40-prs. G.S. gauge. Fuzes, 9 seconds or 20 seconds B.L., Pettman's G.S. percussion,† and R.L. percussion fuze, Mark II. These shell have their powder chambers coated with red lacquer, and are a little over two calibres long.

For details, *see* table, p. 118.

Issue.

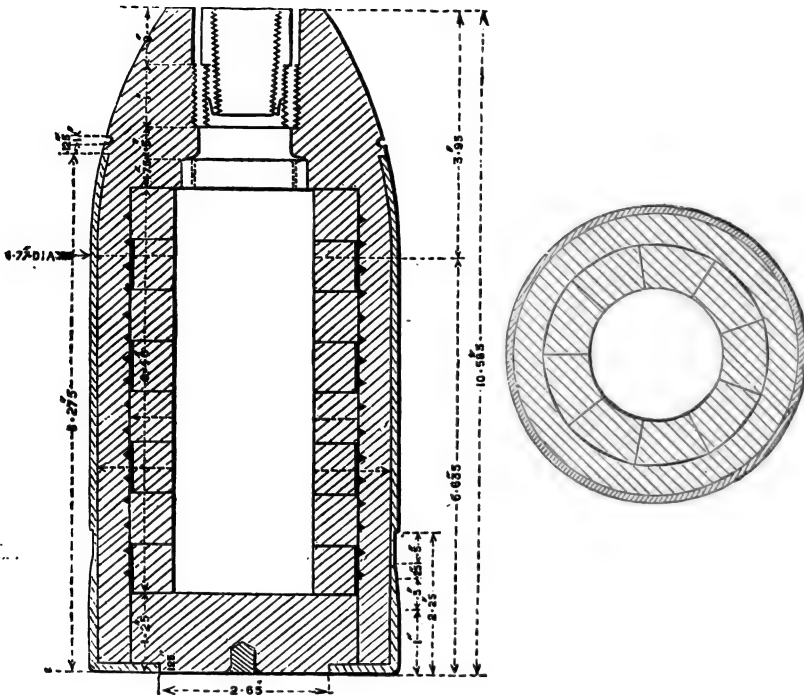
Empty, loose, for garrison service.

Filled and fuzed with Pettman's G.S. for S.S.

* They are thickened at the base to prevent windage, to make them grip at both shoulder and base in ramming home, and to retain the grip till the shot leaves the bore. A cannellure is provided near the base to allow of the lead setting back. In this cannellure the mark or numeral of pattern will be found and the date of manufacture, if it has been manufactured since 1866.

† The Pettman G.S. fuze would answer well when the segment shell is used against wooden ships or against troops behind a thin wall or parapet, but for troops in the open, a fuze which acts on graze like the R.L. percussion, Mark II., is required. The former is issued to navy only; the latter to guns on land fronts only.

40-pr. Segment Shell.*



Field Service Segment Shell.—Field service gauge,† Fuze, B.L. plain Field service percussion (Navy, E. time in addition). Calibres, 20, 12, 9, and 6-prs. segment shell. In the shell, the powder “shell, F.G.” is contained in wrought-iron gas pipe bursters. The ends of the burster are closed by serge and paper discs fastened to metal rings.‡ The latter are secured to the body by three indents punched in.

Field service shell are now carried filled, over the burster is placed a wooden plug covered with serge to keep it from shaking about, the B.L. field service gun-metal plug with leather collar is then screwed in.§

For instructions as to preparing the shell for firing, see p. 33.

For details, see table, p. 118.

These shells are about two calibres long.

1st. Filled and boxed for S.S.

Issue.

* This shell represents one with the Moorsom gauge converted to the G.S. gauge by an adapter, the proper adapter screws in further so as to leave a countersink of .2"; that given above is Mark I.

† As the field service gauge is cylindrical and tapped with a coarse quick screw the plugs are apt to unscrew from the jolting of the limber, care must be taken to examine the plugs frequently, and to screw up any that have become unscrewed. The thread is left-handed.

‡ The present pattern is Mark I.; the 6-pr. burster is of cast iron, and smaller at the bottom to fit the chamber which contracts at the base. B.P. or B.C. on the burster shows that the burster is of a proper length for the brass percussion fuze, which used at first to be called concussion.

§ The 20-pr. shells have string loops on their plugs.

2nd. Empty, loose for transit, or filled and boxed for F.S. If issued empty, they are filled before placing them in the limbers.* For transit to India, empty, boxed. For filling, *see* p. 30.

Use.

Segment shell are very effective against troops in column, and should be burst close to them. A percussion fuze which acts on graze is necessary, the Dartmoor experiments showed that a time-fuze was nearly useless with a F.S. segment shell. When the ground is favourable and hard enough to make a percussion fuze act, the effect would probably be very great. It is necessary to burst the shell close to the object, as they scatter very much, also the shape of the segments is unfavourable to flight. Segment shell have given good results when used against troops behind a thin wall, the shell bursting just as it passed through proved very destructive; the larger calibres would probably be effective against wooden ships. The distance up to which segment shell is effective will vary with the gun; the 12-pr. gun gave very good results at about 1,700 yards at Dartmoor (10 rounds gave 1,194 hits on targets in column at 1,670 yards, bursting within 10 feet of targets), and no doubt would be effective up to 2,000 yards. Beyond 2,000 yards their destructive effect would probably diminish rapidly; from garrison guns the effective range would of course be greater.

Shrapnel shell.

Shrapnel Shell.—G.S. gauge. Fuze, for field service, 5 secs., or for long ranges 9 secs., B.L. and R.L. percussion, II. Calibres, 40, 12, and 9 prs.†

Construction.—The body is of cast iron coated with lead as before described, containing a powder chamber at base, and is weakened by 6 grooves along the sides. Into the powder chamber fits a tin cup to contain the bursting charge, over the cup resting on a shoulder in the shell is a wrought-iron disc or diaphragm into which for the 9 and 12 pr. shells a gun-metal pipe is screwed, tapped in the top for the primer. A tin socket is soldered on to the gun-metal pipe, and this, in conjunction with the gun-metal bush in the head, receives the fuze; lead and antimony balls are placed over the diaphragm, imbedded in rosin, the shell being lined with brown paper to prevent the rosin from adhering too firmly. A kamptulicon or felt disc soaked in kit composition goes over the balls.‡ The head is made of Bessemer steel, ogival in shape, lined with wood and having a gun-metal socket soldered in,§ it is fastened to the body by rivets and screws, and further secured by soldering.

For filling, *see* p. 29.

Primer,
shrapnel shell.
§ 2062.
§ 2268.

Mark II. primer consists of a gun-metal cylinder having a screw thread and two slots cut in the head to enable it to be screwed into the shell. A cup-shaped recess in the head is pierced with three holes,

* These shell must be assumed to be filled when carried in limbers, and the word "filled" will not generally be painted on them. Batteries equipped at Woolwich would have the shell filled and marked in accordance with rule, p. 38.

† The 40-pr. shrapnel is not at present included in L.S. or S.S. equipments.

‡ The first pattern differed slightly in construction from those described. All field service shell are to be altered to the new pattern.

§ There used to be a screw on the exterior of socket, but this has been omitted in later manufacture as it weakened it; the socket without screw is marked P.S. (plain socket) in Mark I. shell. An asterisk in the cannellure shows that the shell has a gun-metal tube instead of the iron tube used in early patterns, and has also some slight manufacturing alterations tending to strengthen the shell; two asterisks show that the junction of the head and body is stronger, the cast-iron rim on the body of the shell being much thicker. Shell marked as above have the plain socket.

§ 2062.
§ 2210.

leading into a chamber filled with L.G. powder; the bottom being slightly closed by a brass ring and a disc of shalloon. Issued, 10 in a small tin box secured like tubes or fuzes.

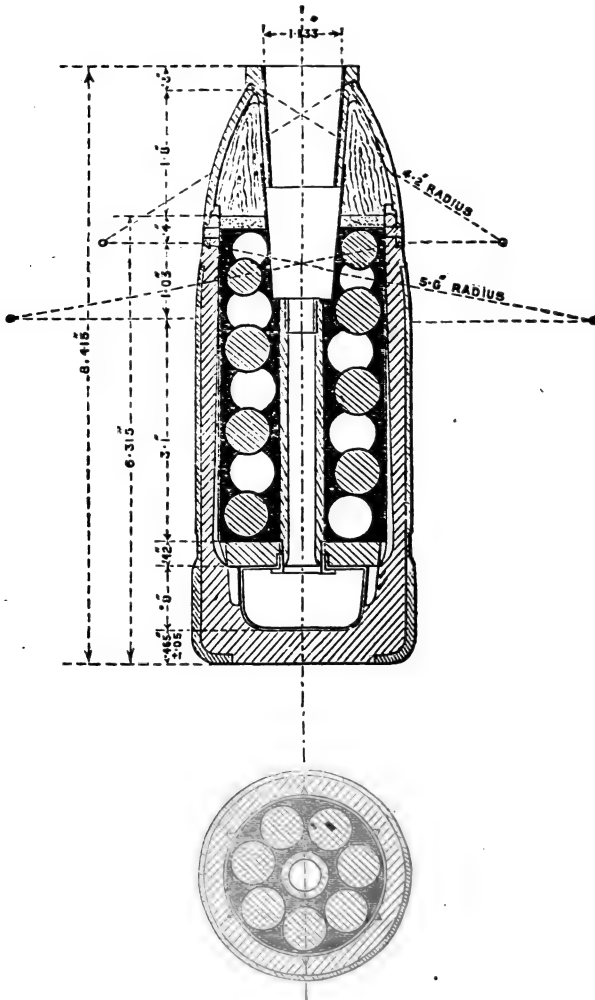
The primer serves to carry the flash of the fuze to the charge, and also prevents the powder from working up into the socket.

Mark I. primer was open at the top, and had a tendency to send the §§ 1395, 2521. flash up, thus causing missfires. No more are to be issued, and all are to be exchanged for Mark II. except those in filled shell.

For details, *see* table, p. 118.

Filled and boxed, primers and plug screwed in. Sometimes issued Issue, 12 and empty, and filled by the battery. For transit to India, empty, boxed. 9 pr.

12-pr. Shrapnel, Mark I.*



* The cut represents the early pattern of 12-pr. shrapnel with an iron tube.

Use. Shrapnel shell like segment would be used against troops, the distance depending on the nature of the gun.

F.S. shrapnel should be burst within 50 yards of the object, and about 10 or 15 feet above the plane. The effective range will be about the same as that of segment shell. When firing against troops in line the shell should be burst at a greater distance from the object than when firing against troops in column.

Common shell, garrison calibres. § 2620. *Common Shell* of the garrison calibres, viz., 7" and 40-pr., have the G.S. gauge. Fuzes, 9 seconds or 20 seconds B.L., Pettman's G.S. percussion, and R.L. percussion, Mark II.

They are cylindrical in shape with ogival head, the chamber is lacquered as usual to protect the burster, their length is generally about $2\frac{1}{2}$ calibres. For details, see table, p. 118.

§ 753. The 7" shell for L.S. weighs about 98 lbs. Owing to the navy finding the recoil inconveniently great, a lighter shell has been introduced for S.S., which weighs about 83 lbs. It may be met with in the L.S.*

Issue. Empty, loose, for garrison service. Filled and fuzed with Pettman's G.S. fuze for S.S., and issued loose.

Use. Use. See page 39.

Field calibres. *Common Shell*, field service. Calibres, 20,† 12, and 9 prs. Gauge, Armstrong field service. Fuze, B.L. plain percussion. For details, see p. 118.

§ 2061. They have a flanged gun-metal socket to take the fuze (Marks I. and II., 9 and 12 prs., are unserviceable, the first having no socket and the socket in II. having been proved to be too weak), the socket contracts at the bottom to prevent the fuze being put in with the rim down.

§ 1708. These shell have the B.L. field service fuze-hole plug. For filling, &c., see p. 29.

§ 1342. The socket in the 20-pr. shell has not been altered, so there is too much play between the plug and fuze.‡

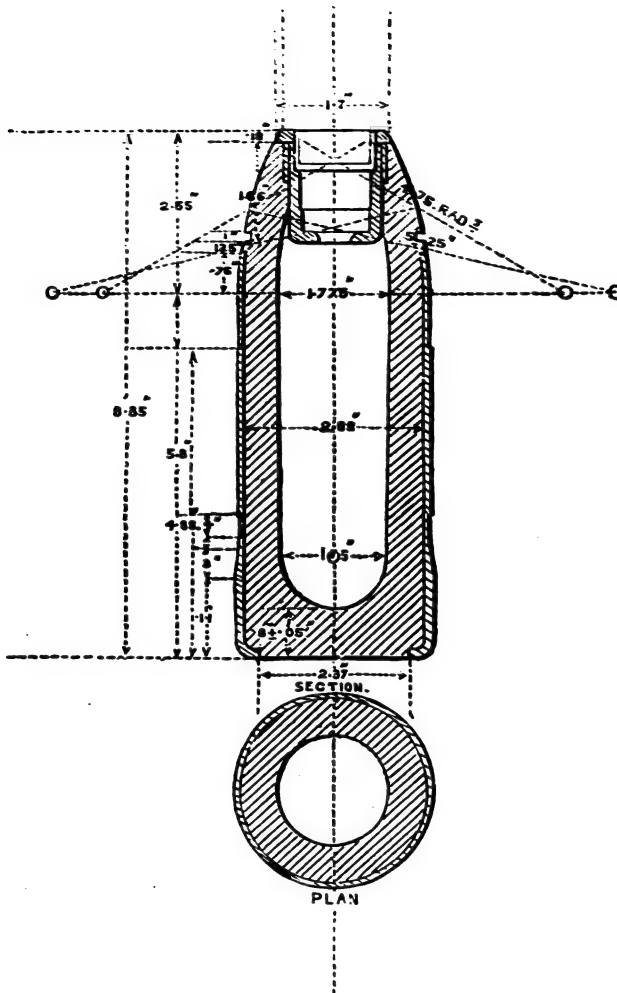
Some of the lead of the 12-pr. shell is turned down on the front to allow it to project beyond the chamber.

* The 7" common shell of 83 lbs. is not suitable for the 7" gun of 72 cwt., because with reduced charges of 10 lbs. and the lighter shell the lubricator does not act properly, the grease being blown out in lumps instead of being evenly distributed along the bore. The 98 lb. shell is to be used with this piece; the lighter shell might, however, be used on an emergency.

§§ 1345, 1426. † A 20-pr. shell with G.S. gauge has been introduced for S.S. Many 20-pr. shell have been converted from the Moorsom to the F.S. gauge by a flanged socket.

‡ The removal of the leather washer from the plug will allow the latter to press on the fuze.

12-pr. Common Shell, Mark II.*



Use. See page 39.

Filled and boxed for field service. Empty, loose, for transit. For Issue.

The various natures of shell for field service are readily distinguished one from another by the following marks :—The shrapnel have their heads painted red and the gun-metal socket projects ; the common shell have the gun-metal of their flanged sockets showing as a ring round their fuze-hole ; while the segment has simply a fuze-hole tapped in the metal of the shell.

Use.

Issue.

Distinctive features of B.L. shell.

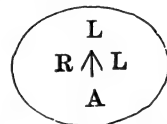
* Though Mark II. is unserviceable, the cut serves to illustrate the construction of the shell. Mark III. only differs by having the socket made thicker.

The garrison service shell are more difficult to distinguish ; the shrapnel shell are known by their projecting socket, but it is sometimes hard to distinguish between common and segment shell ; as a general rule the common are longer and have a more gradually curved head than the segment ; however, the specially light 7" common shell is little longer than the segment, but by looking at the base of the shell it can be seen that the lead coating extends farther in the segment than in the common shell, as the base is secured by the lead coating. By unscrewing the plug, and feeling for the grooves in the head with a bent wire, the segment may be recognised.

The lead coating at the bottom of field service shell is rounded off to prevent their getting enlarged at the base by jolting in the limbers.

The most important mark on these shell is the Roman numeral showing the pattern, which will be found stamped in the cannellure on the lead coating. Shell made in the Royal Laboratory have R.L. on

the base and generally Z. to indicate zinc attachment ; a mark thus—



in the cannellure indicates lead and antimony coating ; the date of manufacture will also be found there. Shell made at Elswick have E OC on the head. I ↑ A shows that the shell was passed by the Inspector of Artillery ; these shell would generally have a lead and tin coating. U. would show that the lead coat was attached by the undercut method of attachment ; these shell would be more liable to strip than those with zinc attachment.

Case shot.

Case Shot is made for the Armstrong guns of all calibres. To prevent the projectiles going too far in ramming home, either lead rings or studs are placed round the base of the shot. They are *not* intended to take the rifling.

Case is now made of the Royal Laboratory pattern. Some case was made of Reeves' pattern in which the balls are packed in wood, but the manufacture has been discontinued.

The present pattern case shot consists of a body made of three pieces of tin soldered together longitudinally. This is done to ensure uniformity in breaking up. The bottom is of tin, soldered on to the body, and on the outside of the bottom is a wrought-iron ring, riveted on ; in the inside a wrought-iron disc fits loosely on the bottom, on this rest three wrought-iron segments, forming a lining to the body.* The balls are of mixed metal (lead and antimony) up to the 20-pr. inclusive. The 7" and 40-pr. have iron sand shot of 8 oz. In all cases the balls are packed in a mixture of equal parts of clay and sand. The 7" and 40-pr. case have the top end of the tin body fringed, and the fringes are bent down over a top of tinned iron, fitted with an iron handle in the case of the 7". The lower natures have a tin top covering, a zone-shaped piece of wood, which rests on the top of the balls. The top of all case is stamped with the numeral of its pattern and the calibre of the gun for which it is intended.

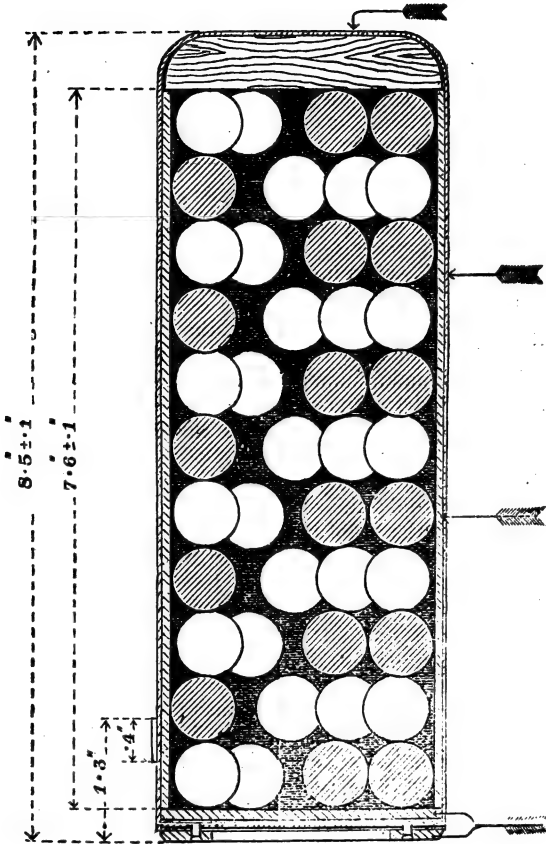
The 7" case is interchangeable for the 7" R.M.L. and R.B.L. guns.

The studs are small enough to fit easily in the large grooves of the R.M.L. gun.

For details, *see* p. 118.

* The use of these segments is to strengthen the case against external blows in travelling, &c., while they are obviously no check on pressure from within. They also protect the bore from injury by cast-iron sand shot when the latter are used.

12-pr. Case Shot, Mark IV.



Against troops up to 300 yards; on hard ground, with heavy guns, it is not necessary to give elevation, as the bullets run along the ground; in soft ground or against cavalry elevation should be given according to distance. About 1° of elevation may be given from field guns at 300 yards range.

40-pr. and smaller calibres in boxes for transit; 7" loose.

Issue.

Solid Shot.—For all but 7". They are only used for practice in the L.S. They have much the same form and length as segment shells.

Solid shot.

Loose, but might be packed in boxes if convenient for transit.

Issue.

Drill Shot.—For the larger guns down, to the 20-pr. inclusive, recovered shell, with their coating turned down, are used. For the 9 and 12 prs., special shot are used with the lead coating extending over the head, to avoid injury to the copper bush. The 6-pr. has a special drill shot.

Drill shot.
SS 1742, 942,
1088.

The shell or shot used for drill may be known by the absence of cannelures.

CHAPTER VIII.—CHARGES FOR B.L. ARM-STRONG GUNS AND MISCELLANEOUS STORES CONNECTED WITH CHARGE.

THE weight of the charge is $\frac{1}{3}$ of the weight of the projectile, except for the 7" guns. The 7" of 82 cwt. has a charge of 11 lbs. ; the 7" of 72 cwt. has a charge of 10 lbs. In the L.S. the 98 lb. shell is used with both guns.*

The powder employed is L.G., under the rule given on page 7 ; but R.L.G. will be used when stock of L.G. is exhausted.

The cartridge is made of serge, the bottom is formed of a circular piece, and the cylindrical part from a rectangular piece ; the seams are made to overlap and are sewn with three rows of stitches, except the seam forming the junction of the body and bottom in the 12-pr. and under, where two rows of stitches are used. The cartridges are hooped with blue braid ; the empty cartridges are issued with braid inserted ; one end of the braid has a loop through which the loose end is passed, and a single bend is formed with it on to the loop. Care is necessary, as men are apt to make the knot off the loop, or a wrong knot, which slips and the hooping is rendered useless.

Lubricators.

A lubricator, consisting of two thin cups of tinned iron soldered together, containing a mixture of equal parts of tallow and linseed oil, attached to a wad of felt backed by millboard (the edges of the wad being coated with beeswax), is inserted into the cartridge.† It is put on the top of the powder, just above the top hoop in all cases,‡ except the 40-pr. S.S. and 7" in both services, which have their lubricators detached to save room in the magazine. With these latter a wooden socket is choked into the neck of the cartridge, on to which the lubricator screws. The use of the lubricator is to prevent the gun leading ; the cups being broken by the discharge the lubricant is squeezed out, and the wad following wipes and polishes the bore.

Sockets, wood,
B.L. cartridges.
§§ 1939, 2170.

Issue.

Lubricators are packed and issued in "Laboratory packing cases," number varying with nature of lubricator and size of case.

All B.L. service cartridges are choked with twine ; the 7" L.S. and S.S., and the 40-pr. S.S. have a running string in the mouth for choking in the socket for the lubricator. The chokes of all, except the 7", are cut to a length of one inch ; the 7" choke is cut to $1\frac{1}{2}$ ".

Paper cylinders,
B.L.
cartridges.

§ 792.

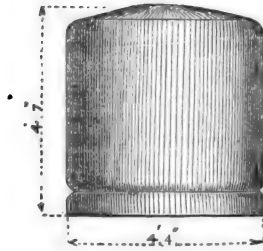
With the 7" 40§ and 20 pr., a varnished paper cylinder is used to bring the cartridge up to length, the cartridge is half filled with powder, the cylinder is next inserted, so as to be in the centre of the cartridge, and then the rest of the charge. One end is formed by choking up the

* See footnote, p. 68.

† In future manufacture and repairs the whole of the felt wad to be covered with beeswax. § 2970.

‡ This is important, as the grains of powder work up between the lubricator and the cartridge, cutting the serge, unless the cartridge is very tightly hooped below the lubricator.

§ The same cylinder is used for the 40-pr. and the 11 lbs. charge of the 7".

Cylinder for 7-inch, 10 lbs. charge.

cylinder on a former and closing the hollow by a paper plug ; the other end has a groove choked into it, so as to support a cardboard disc, which is glued in. The end formed of the cylinder itself is the strongest, and is placed downwards in the cartridge. These cylinders are issued separately in vats containing 220 for the 10 lbs. cartridge 7" gun, 390 for the 11 lbs. cartridge 7" gun or for the 40-pr., and 700 for the 20-pr. cartridge. Issue.

It was found necessary to varnish the paper as otherwise it absorbed § 1939. moisture and damaged the powder, for this reason also the paper socket for the lubricator was abandoned, as paper is very apt to absorb moisture when unvarnished ; it is never desirable to have it in contact with powder.

The cartridges are marked B.L. in addition to the nature of gun and weight of charge, thus the 12-pr. cartridge is marked "12-pr. B.L. 1 lb. 8 oz.," when filled with L.G. powder "L.G." is marked in red.

Filled B.L. cartridges are issued in the same description of cases or barrels as are used for S.B. cartridges, *see* table, page 112 ; empty cartridges are issued in bales as for S.B. ordnance, *vide* page 47. Issue.

Such cartridges as are issued in brown paper bags, *i.e.*, all those which like field service are not kept in metal lined cases, have the marks on the bags as well. As mentioned before, the monogram of the station at which the cartridges are filled is marked on them, except those filled by the R.A. for their own use.

Tin Cups.—Are used for all B.L. guns to prevent escape of gas, they have a rim .32" deep which is pressed back by the explosion of the powder against the sides of the bore, thus preventing the gas from getting behind them. The central hole allows the flash from the tube or primer to reach the cartridge. Tin cups. § 1163.

The tin cups are only used for practice and exercise with field guns and the 40-pr., as they have got a copper bush which stands the escape of gas better than iron, but the 7" guns require them also as a service store, as these guns have no copper bush.* § 1794, Cl.197 A.C. /71 and errata A.C. December /71.

For the 7" guns one tin cup per cartridge is to be issued for service, and as many as required are to be used at practice ; they are packed in packing cases for laboratory stores. Issue.

* Some unserviceable 7" cups may be found, the serviceable have L.G. 7-253 § 1815. stamped upon them.

Primers.
§ 943.



Issue.
§ 913.



Saluting
charges.

Issue.

Drill car-
tridges.

Issue.
Gauges, filled
cartridge.
§ 1695.

Primers are used for the 7" and 40-prs., they consist of tubes of leather paper about $2\frac{1}{2}$ " long, driven with mealed powder and pierced like a tube, having strands of red worsted attached, which keep the primer in the hole in the vent piece. These are the only special primers made, they are painted black and packed 25 in a tin cylinder. Field batteries, however, carry 15 blank muzzle-loading small-arm cartridges in a blue serge bag with each subdivision, they are only to be used if the friction tubes are found to fail to fire the charge, the powder is poured into the hole in the face of the vent piece, and the paper of the cartridge placed on top to prevent its falling out, it is very seldom necessary to use them.

Saluting or Exercise Charges are generally similar to the service cartridge, except that they contain less powder, have no lubricators or paper cylinders, and are choked with worsted, as twine is liable to carry fire. They have a becket of braid sewn on behind to facilitate unloading if necessary, the braid is sewn down for 1" at each side on the edge to prevent jamming with the vent piece; the 9 and 12 prs. have worsted instead of braid, which was found to obstruct the flash. For details, see table, page 112.

The 12-pr. or 9-pr. has a sawdust cartridge stitched on in front to lengthen it. The 6-pr. has the same arrangement.

The cartridges are marked with the nature of gun, weight of charge, and also with the word "Blank," thus, 7" B.L., 7 lbs., Blank. Exercise L.G. or R.L.G. is used.

Filled blank cartridges are issued in the same manner as service cartridges, the empty ones are made up in bales.

Drill Cartridges.—Are made of a wood cylinder covered with felt and placed in a leather case, the base of the cartridge is shod with copper, and they have dummy lubricators, the detached lubricators having gun-metal stalks screwing into gun-metal sockets in the cartridge. The cartridge is marked in black same as the service cartridge, viz., with the nature of gun and weight of charge.

Loose, in numbers as demanded.

Two sorts, viz.: (1.) Brass ring for diameter, description and use similar to those for S.B. cartridges (page 53). (2.) Wood sliding for length. This is an open frame of wood-work with a cross piece having a certain amount of play allowed as limit of error. The cartridge is passed beneath to test its length.

CHAPTER IX.—WOOLWICH SYSTEM. PROJEC- TILES FOR R.M.L. GUNS AND HOWITZERS.

BEFORE entering on the details of the ammunition it is necessary to point out the meaning of a few of the terms used in connection with studded projectiles.*

* It is important to clearly understand the difference between "*windage*" and "*clearance*." "*Windage*" is the difference of the diameters of the body of the projectile, and the bore of the gun. In all Woolwich guns it is .08". Thus the diameter of the body of a 10" projectile is 9".92.

Clearance.—If the depth of the groove is less than the projection of the stud beyond the body of the shot there will be “clearance,” that is, there will be an interval between the body of the shot and the bore of the gun, and consequently the shot will rest entirely on the studs, the amount of clearance will be the difference between the depth of groove and the projection of the stud, thus in some of the Woolwich guns the depth of groove is $\cdot 18''$, the projection of stud is $\cdot 195''$, therefore there is a clearance of $\cdot 015''$, this is the mean clearance, and is liable to be reduced by manufacturing limits. With iron guns it is not generally considered of much importance to have clearance, but where bronze is used it becomes essential as the iron projectile would injure the softer metal of the gun. If on the other hand the depth of the grooves was greater than the projection of the stud, the metal of the projectile would be in contact with the bore of the gun; in this latter case the studs only serve to twist the shot, whereas in the former they give it both direction and twist.

When a shot is rammed home the stud bears on one side of the groove, and on coming out, on the other. The former is called the loading edge, the latter the driving edge. Obviously the shot in entering the gun rotates in the opposite direction to that in which it rotates on coming out, and hence the studs must be pressed on different sides, according to whether the shot is being rammed home or being fired. If the sides of the studs be perpendicular to the projectile, or to speak more correctly normal to its surface, and the groove be of a corresponding shape, the stud will remain at the bottom of the groove, but if the side of the stud be made an inclined plane, and the side of the groove corresponding in shape, the stud on being pressed against the groove will have a tendency to run up the inclined plane, and by so doing will centre the shot in the bore, that is, will bring the axis of the shot to correspond with the axis of the gun; the windage will in this case be evenly distributed all round the shot, and the shot will not be in contact with the bore, hence with bronze guns centring is desirable, as even with a groove of a depth equal to the height of the stud there would be no contact.

In the Woolwich system the rotation is given by studs* made of an alloy of copper and tin, 10 parts of copper to 1 of tin, they are secured to the projectiles by being pressed into undercut holes.†

The depth of the groove is in the later patterns of guns up to the $9''$, $\cdot 18''$, in the larger guns the depth is $\cdot 2''$, the bottom of the groove is circular, but struck with a radius of $3''$, so in no case is the bottom of the grooves concentric with the bottom of the gun (this entails the necessity of planing the face of the studs instead of the simpler operation of turning,) the edges of the grooves are circular, struck with radius of from $\cdot 3''$ to $\cdot 25''$ according to the nature of the gun; the width of the groove is $1''\cdot 5$, the studs are formed with faces and shoulders corresponding to the grooves, they project $\cdot 195''$ up to the $9''$, and $\cdot 215''$ in the larger shell, beyond the body. The width of the rear stud is $1\cdot 42''$; that of the front stud is limited by the amount of twist of rifling at the muzzle.

From the above dimensions of grooves and studs it will be seen that there is a clearance of $\cdot 015''$, practically there is no centring, the play

* The projectiles have all two rings of studs, except the Palliser and common shell, Mark II., for the $12''$ 35-ton gun and Palliser and common shell for $12''\cdot 5$ gun, which have three; when only two rings were used the studs sheared.

† To avoid injuring the studs, planks are provided for rolling the projectiles on, 1 per 3 guns or under. This applies only to projectiles for $9''$ guns and upwards.

A clip is used for lifting R.M.L. projectiles, from $7''$ to $12''\cdot 5$.

§ 2490.

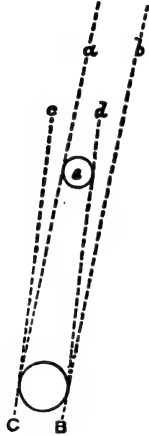
§ 2206.

§ 2418.

between side of stud and side of groove is $\cdot 08''$, the windage is $\cdot 08''$ over the body and $\cdot 05''$ over the studs.

In this system the twist employed is an increasing one in all, except the 7" in which it is uniform. When the twist is uniform the studs are both of the same size, and are placed on the shot so that their direction corresponds with the direction of the grooves. Where the twist is increasing, the front stud is made smaller than the rear one, as it is necessary to regulate the direction of the studs so as to fit both the lowest and the highest amount of twist which the groove has, thus suppose *a b* in the diagram to represent the most rapid twist, and *c d* the slowest twist of the groove in the gun, the stud *e* in order that it may fit both grooves must not extend beyond the lines *a C*, and *d B*. The advantage aimed at by the increasing twist is to diminish the strain near the breech of the gun by allowing the shot to move on at first without much rotation, the spin being given chiefly by the grooves as they approach the muzzle. A certain amount of work must be performed to give rotation, and it is considered desirable not to throw more work on the breech of the gun than is absolutely necessary.

Studs and Grooves.
Increasing Twist.



For convenience in loading, the rear stud is placed at the least 4" from the base of the projectile, thus allowing the shot to be placed in the bore in any position and then turned round till

its studs are opposite the grooves. The front studs are placed as much before the centre of gravity as the rear ones are behind, in all except the Palliser projectiles, where the centre of gravity is very far forward. The studs are the same distance apart for all projectiles for the same gun, this facilitates gauging. The shape of the head of the projectile is ogival, for common shell struck with a radius of $1\frac{1}{2}$ calibres; *e.g.*, a 10" shell would have its head struck with a radius of 15". The 7", 8", and 9" Palliser shot have had their heads struck with a radius of $1\frac{1}{2}$, but all now have a radius of $1\frac{1}{2}$ calibres.

The projectiles for each gun may be recognised by the calibre being cast on the base, the weight of gun is also given for the 12" projectiles. Shell cast prior to 1873 are not thus marked, but they may be known by the number of studs in each ring, except in 11" and 12", which have the same number of studs. Any 12" 35-ton projectiles issued before 3/73 will have 35-ton stamped on the rear studs.

The 7" has 3. Twist uniform 1 in 35 calibres.

" 8"* " 4. " increasing from 0 to 1 in 40.

" 9" " 6. " " " 0 to 1 in 45.

" 10" " 7. " " " 1 in 100 to 1 in 40.

" 11" " 9. " " " 0 to 1 in 35.

The 12" 25 tons has 9. " " " 1 in 100 to 1 in 50.

" 12" 35 " " 9. " " " 0 to 1 in 35.

" 12" 5 38 " " 9. " " " 0 to 1 in 35.

* The 8-inch are for S.S. only. A 90 cwt. 7" gun has been introduced for S.S.; the ammunition is the same as for the heavier gun, except that Palliser projectiles and battering charges are not to be fired, and the double shell is not to be used with it.

The weight to which the projectiles approximate are—

12" .5	-	800 lbs.
12"	{ 35-ton	- 700 "
	{ 25 "	- 600 "
11"	-	530 "
10"	-	400 "
9"	-	250 "
8"	-	180 "
7"	-	115 "

The weights include the charges of shells except for shrapnel.

* *Gauges*.—A cylinder gauge is issued to stations of inspection for each nature of Woolwich gun; any projectile which passes through the cylinder is certain to fit the gun, as the dimensions of the cylinder are slightly less than those of the gun (.045" less in diameter). For guns with uniform twist only one set of grooves is required; for the increasing twist a second set of grooves is required to test the dimensions of the front stud. When using the first set of grooves, the cylinder should pass completely over the projectile; when using the second, the front stud should touch the top flange of the gauge, in which a slot is cut to enable the stud to be seen. Ring gauges over body and studs have been sealed for use on board H.M. ships, with garrison batteries and by control officers.

All projectiles of late pattern, except case, have the rear edge rounded off to facilitate loading.

The projectiles used with the Woolwich guns are Common, Shrapnel, and Palliser shells, Palliser shot, and Case shot. With the 7" gun a double shell is used in addition. All the shell have the G.S. gauge fuze-hole, except Palliser shell, which require no fuze.

Common Shell are made for all calibres. Gauge G.S. Fuze,† Pettman G.S. percussion. They are 3 calibres long, except the 12" 25-ton, which is only 30"; the twist of the gun being too slow to give good shooting with a longer projectile, the weight of the empty (498 lbs. filled) shell is only 460 lbs.; the shell for the other guns approximate closely to 3 calibres, and their weights when filled to the weights given above for the projectiles of their respective guns.‡ All the shell have two extractor holes in the head, the interior is lacquered, like other common shell, they are to be filled completely with powder, see p. 30; their details and approximate capacity is given in the table, page 116.

The numeral indicating pattern will be found in front of one of the front studs, and on a rear stud the date and × indicating that the stud is planed to correspond with curve of groove, and not simply turned as the earlier patterns were.

They are issued loose, either filled and fuzed with Pettman G.S. fuze for the navy, marked "Filled, Bag," with the date of filling and monogram of station in red, and having the red naval wad cemented in over the fuze, or empty with blue wad over G.S. plug.

For L.S. issued empty, loose, with G.S. plug.

* Low ring gauges over studs are issued to stations of inspection.

† Time-fuzes will not in future be used with common shell fired from R.M.L. guns above the 80-pr. calibre, except for S.S. in the case of the 7-in. R.M.L. gun when using the 14 lbs. charges. No time-fuzes are used in the L.S. The equipment assumes that the Woolwich guns will only be found on sea fronts.

‡ The common shell for the 12" 35-ton gun weighs about 615 lbs. when filled; it could not be made as heavy as the Palliser shell without unduly increasing its length. It is to be fired with full charges, 85 lbs. P. only.

Gauges.
§§ 1546, 2000,
2477, 2486.

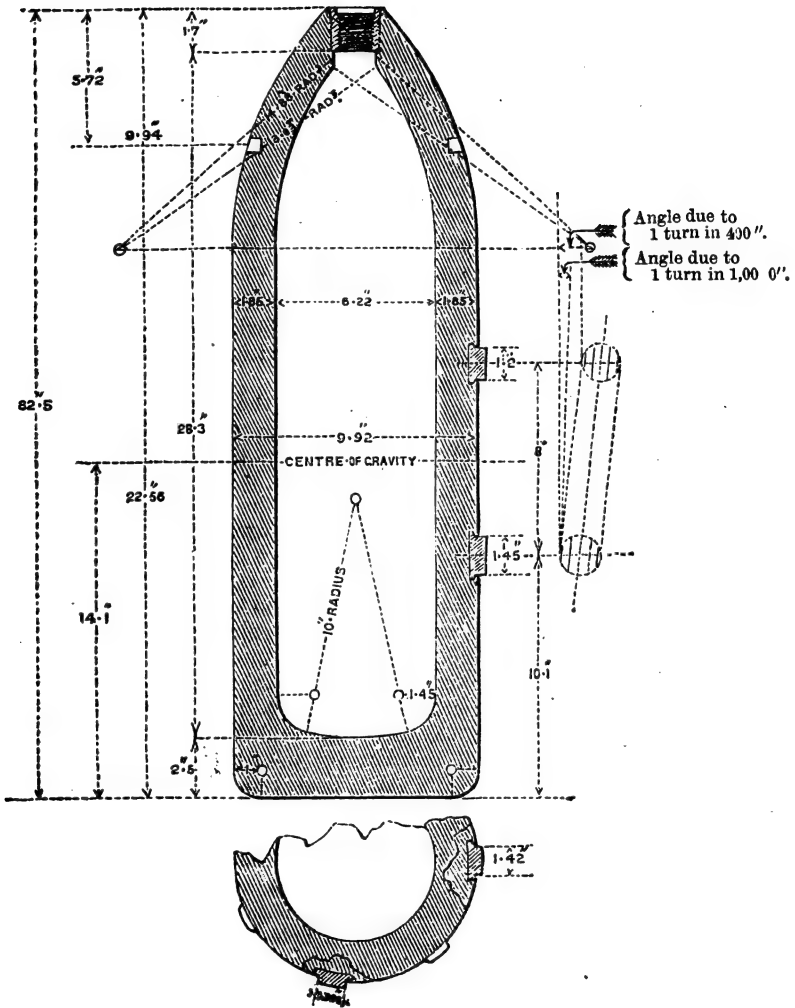
Common
shells.

Issue.

§ 2360 and
Errata, Chan-
ges, December
1872.

§ 2618.

As regards the power of these shell it may be noticed that the 12" 35-ton contains about 6 times the amount of powder that the 10" spherical shell did, the largest used with the old S.B. gun.



10" Common Shell, Mark I.

Double Shell.—For 7" Gauge, G.S. Fuze, Pettman's G.S. (see note, p. 77). It is a shell nearly 4 calibres long strengthened by 3 ribs internally, otherwise resembling the common shell. It is intended chiefly

for use against wooden shipping, and does for ranges up to 2,000 yards ; above that it becomes inaccurate. For details, *see* table, p. 116.

Marking, issue, &c. similar to common shell. A bag is used for filling.

Shrapnel Shell.—Gauge, G.S. Fuze, 9 seconds M.L. Shrapnel is made for all calibres.* These shells resemble in general principle the shrapnel already described for F.S., p. 66. They consist of a cast-iron body with walls of about the same thickness as those of the common shell. The shell is weakened internally by longitudinal grooves, and there are also weakening grooves in the base. The bursting charge is contained in a tin cup at the base, coned to admit of easy unloading ; and over this cup is a coned wrought-iron diaphragm. The central tube is of iron lacquered internally, and screwing into the diaphragm. The socket is entirely of gun metal, tapped to take the plug or fuze at the top, and at the bottom to take the primer. The end of the socket fits into the central iron pipe. The contents are iron sand shot, 2 oz. in weight up to the 9" inclusive, and 4 oz. in weight for the larger calibres. Rosin is run in between the balls to bind them together, and a lining of brown paper prevents the balls and rosin from being in actual contact with the shell walls. On the top of the balls is a felt ring. The head is nearly the same in detail as the head of a F.S. shell, and is secured to the body by rivets and twisting pins. It has extractor holes, bushed with tin sockets. They resemble the common shell as to studding, &c. The 12" 25-ton is an exceptionally short light shell, 29"·75 long, weight 496 lbs., for the same reason as given before for its common shell ; all the rest approximate closely to the general weight of projectiles given above.† As before stated, the bursting charge is of pistol R.F.G. or F.G. powder, and is either weighed or measured. The charges and details are given in the table, p. 116.

(1.) Filled and boxed for S.S. with primer inserted. (2.) Empty, loose, for S.S. It has been decided that these shells are not to be issued
Issue. §§ 2357, 2406, 2480.

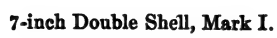
Would be available against troops, and owing to the great distance to which the shell keeps up its velocity would probably be useful up to about 3,200 yards ; beyond this distance the 9 seconds fuze would not act. The shell gives a good cone of dispersion if burst within 300 yards of the object ; but should the troops be in close order it ought to be burst much nearer, and would be probably more effective if burst about 100 yards from the object.

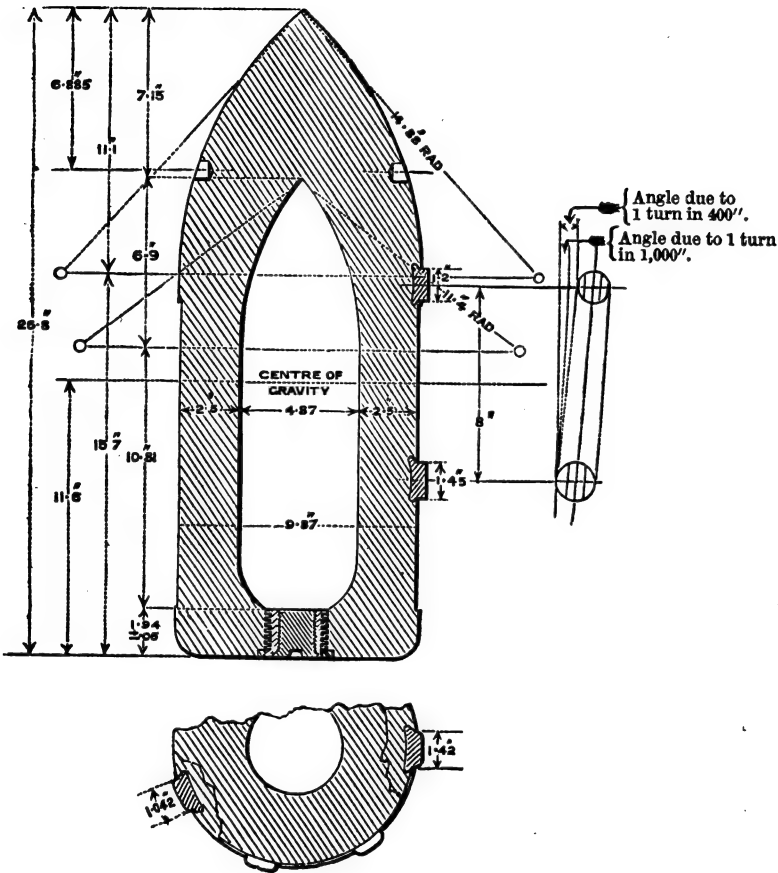
Palliser Shell are made of all calibres ; they have no fuze-hole, so can be distinguished from all projectiles except Palliser shot. To prevent mistakes the Palliser shell have their tops painted white ; they can, moreover, be readily distinguished from the shot of early patterns by looking at the plug in the base, the plug having a wrench hole for unscrewing while the shot has none.‡ Shell made since 1872 have the word "shell" cast on the base to distinguish them from the new pattern shot which have gun-metal plugs in the base. They are all about 2½ calibres in length. The weight of the filled shell corresponds with the weights laid down as the general weight of the projectiles of each calibre. The head is ogival struck with radius of 1½ calibres.

* None as yet for 12"·5 gun.

† The shrapnel shell for the 12" of 35 tons weighs about 612 lbs. It would be too long if made as heavy as the Palliser shell.

‡ This does not apply to the last patterns of Palliser shot.





* 10-inch Palliser Shell, Mark I.

It will be seen from the sketch that they are much more solid in construction than common shell, having less capacity for powder; the

* The cut does not coincide in dimensions with the present pattern, but serves to illustrate the general construction of these shells.

weight is brought well forward so as to strengthen the head and ensure penetration. In studding and extractor holes they resemble common shell; they are lacquered inside; the base has a gun-metal plug screwed in. These plugs are carefully fitted to each shell before issue. It is necessary to replace the plug in the shell from which it is taken, otherwise a misfit may occur.

These shell are cast from a harder and whiter variety of iron than common shell; the heads are cast in iron moulds called "chills;" the bodies are cast in sand. The effect of casting the metal in chills is to cause it to cool more rapidly; the carbon which is present in the iron remains chemically combined with it, and the metal so produced is intensely hard and white in colour. It has great strength to resist crushing, but to this diamond-like hardness is also added the quality of brittleness. As the body does not require this great hardness, and does require tenacity, it is cast in sand, and cools more gradually than the head, the carbon separating and giving the metal a grey mottled appearance. The iron in this state is much more tenacious.

When the whole shell was cast in "chills," the metal produced was so brittle that it sometimes broke up in store.

Owing to the bases of some of the shell manufactured prior to 1870 having been found defective, all shell in store at Woolwich, and at large out-stations, were examined; those found to be unserviceable were broken up. Any found unserviceable or doubtful at out-stations are sent to Woolwich. It is enough here to say that the chief test employed is to hammer the base all over with a sharp pointed hammer, which detects any weak place by breaking it in. Those examined and found serviceable have an E. stamped on one of their studs.

To fill a Palliser Shell, see page 30.

The capacity of the shell for powder varies with the several patterns of the same shell. The table, p. 116, gives the capacities of the latest patterns. They will generally be guide enough as to the quantity of powder which should be put into the shell, but it is to be noted that Mark I. of the 8" and 9" shell were of small capacity,* holding respectively 2 lb. 13 oz. and 2 lbs. of powder. Some of these shell, even of Mark I., have the large capacity. They may be known by their being the same length as later Marks.

The serge bags containing the bursting charges are of the shape of a soda water bottle, with a piece of blue worsted braid at the neck for choking. Each calibre has its own bag; the 8", 9", and 11" have each two different sized bags, to correspond with the large and small capacity of the shells.

The numeral indicating pattern will be found on the base of the projectile; in the later patterns the numeral will also be found on a rear stud. The date of manufacture and cross will also be found on a rear stud. An E.† on the stud means that the base has been tested for porous places.

Paint.

Black, with white top.

* The 11" shell, Mark II., was formerly a shot, and is of smaller capacity than the Mark I. shell.

† Shell manufactured after the month of July 1872 will not have this mark.

Palliser shell are used for penetrating iron plates on forts or vessels. Use. Owing to the shock on striking, the powder explodes without any fuze being required. As a rough rule it may be laid down that a shell fired with a battering charge at a distance of 200 yards from the object is capable of penetrating a depth of iron exceeding the calibre of the shell by two inches. Thus a 9" shell would penetrate about 11" of iron plate.

Loose. Filled for S.S., wrench hole in base plug filled with red Issue. lead, to enable a filled shell to be distinguished by touch. Empty for L.S.

Palliser Shot.—Of all calibres except 12"·5 12"(35-ton), and 11", they Palliser shot. are very little shorter than the Palliser shell. The heads are ogival. The 12" and 10" have a radius equal to $1\frac{1}{2}$ calibres; the 9", 8", and 7" have had $1\frac{1}{4}$ radius, but all are now manufactured with a radius of head equal to $1\frac{1}{2}$ calibres. They resemble the shell, having a hollow in the centre; the wrought-iron plug closing the base is screwed in permanently in patterns previous to 1871. It is necessary to have this hollow to bring the shot up to the proper length, and it is also supposed to render the shot less liable to split up under the action of molecular forces, which they occasionally did in store. They are more solid about the head than shell. The earlier patterns had the base closed by a wrought-iron plug pressed into an undercut hole. To strengthen these § 2040. shot by covering the junction of plug and base, the wrought-iron plug has been bored out and tapped to take a screw plug of wrought iron, with a rounded head, which covers the weak part of the base. All Palliser cored shot of patterns antecedent to those approved 7/3/70, § 1872, are to have their bases strengthened. In the latest patterns the base has been closed by a gun-metal plug in the same way as the shell, and a burster can be placed in the shot if wished, thus converting the shot into a shell. The word "shot" is cast on the base of all made since January 1873. For details, *see* table, p. 116.

* To penetrate iron plates, said to penetrate better than shell in Use. oblique firing. (Extracts, vol. viii., p. 65.)

Empty, loose.

Issue.

Black.

Paint.

* There is now but little difference between the shell and shot, the latter have smaller capacity, are a little shorter, and rather more solid towards the head. No bags are provided in the equipment for shot, therefore it would be necessary to demand bags specially if bursting charges are to be used.

The later patterns generally resemble those made for smaller guns, Crse shot. *see* p. 70. They differ in having an iron disc at bottom instead of a tin bottom with iron ring riveted on, and in having the bodies made of one piece of tinned iron instead of three pieces of sheet tin. The balls are 8 oz. iron sand shot, packed in clay and sand. The 7" case is the same as that for R.B.L. 7", *see* p. 70.

For details, *see* table, p. 116.*

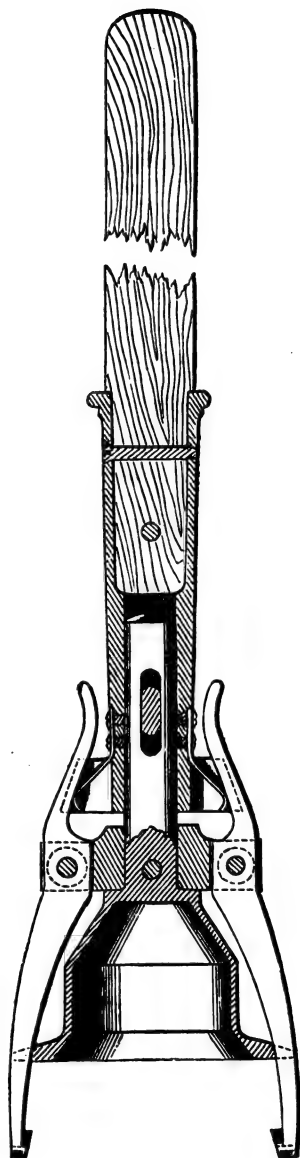
R.M.L. case is available for longer ranges than the S.B. case, but the number of balls they carry is small compared to the weight of the projectile. Good results have been obtained with case fired at targets at a distance of 500 and 550 yards. At ranges below 500 yards double shotting has given very good results.

Loose.

Five sizes, viz., 7", 8", 9", one size for 10", 11", 12", and one for 12"·5.

The action will be readily understood from the sketch; the head fits on to the head of the shell, and by turning round the handle the teeth are brought opposite the extractor holes, the spring forcing them in. In withdrawing the staff the socket moves slightly in a slot in the shaft of the head bringing two wedges fixed on each side of the springs to support the counter jaws. This extractor has no means provided to loosen its hold when in the bore. A canvas bag is used to cover the head of the extractor.

The service projectiles are used for drill purposes in order to accustom men to their use.



Issue.

Extractors.

§§ 1712, 1681,
2850.

Drill.

§ 2267.

* See Changes, § 2444, ordering certain marks to be broken up and others to be repaired.

6·3", 8", AND 10" R.M.L. HOWITZERS.

The ammunition for the 6·3, 8, and 10 inch rifled howitzers is for the most part in the experimental stage.

Common shell and shrapnel shell have been tried, but no pattern of shrapnel has been decided on.

The small charges used render the construction of a percussion fuze difficult.* The R.L. percussion fuze, Mark II., requires a 7 lb. charge to ensure its action from the 8" howitzer. A special 30 seconds time-fuze has been tried. See Extracts, vol. XI., p. 53.

Charges.—See table, p. 114.

8" common
shell.
§ 2539.

8" Common Shell.—This is the same as the shell for the 8" gun, except as to the studs, which are made to suit the quick uniform twist of the howitzer (the twist is 1 turn in 16 calibres). As the twist is uniform, the front and rear studs are of the same size, so the shell can be easily distinguished from that for the gun.

For capacity, &c., see 8" gun shell, table, page 116.

This shell has evidently a large margin of strength, as it has only to stand a charge of 10 lbs. in the howitzer, while it is strong enough to stand a 35 lb. charge. If desired, its capacity could be increased without unduly weakening the shell.†

Case shot, 8".
§ 2742.

The 8" gun case shot is to be used with the 8" howitzer with a 10 lb. charge.

Extractor.

The extractor for the 8" howitzer is the same as that for the 8" gun, but has a shorter stave.

* A fuze on the same principle as the Prussian percussion fuze may prove successful. The striker in the Prussian fuze is kept in its place by a safety-pin which passes freely through a hole in the fuze; the pin has a large head projecting beyond the shell. This pin cannot fall out while the shell is in the bore, but on leaving it, the centrifugal force causes it to fly out. See "Romberg sur les Fusées."

† A shell has been made of 150 lbs. weight with same external dimensions as the 180 lb. shell, but is not yet sealed.

CHAPTER X.—CHARGES FOR WOOLWICH GUNS AND HOWITZERS.

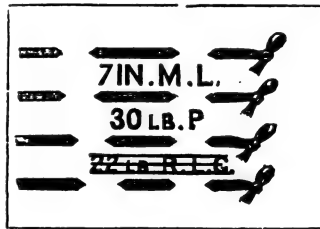
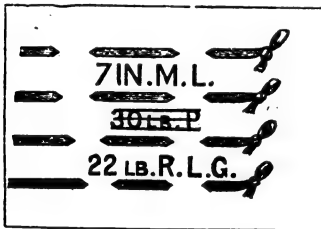
PEBBLE powder has been introduced for the battering charges of all rifled guns of 7" calibre and upwards, and all full charges of 40 lbs. and upwards, L.S. and S.S. For full charges below 40 lbs. R.L.G. will be used in the S.S. and L.G. in the L.S. L.G. is to be marked in red on cartridges containing L.G. powder. For reduced charges, exercise R.L.G. or L.G. is used.

P³. powder is used with the 12"·5 gun.

Until 1876 cartridges for the Woolwich guns were made of serge. At the beginning of that year it was ordered that all cartridges manufactured in future for R.M.L. guns (with the sole exception of the 7-pr. 4 oz. charge, which has a red shalloon cartridge,) should be of silk cloth. Existing cartridges of serge up to the 85 lb. charge may be used up, but charges of 85 lbs. and upwards are invariably to be contained in silk-cloth cartridges.* § 2838.]

The cartridges, both serge and silk cloth, are made in two pieces for P². and P. powder charges. They are cylindrical in shape, terminating in a cone to fit the chamber of the gun. The full and reduced cartridges for 7", 8", and 9" guns are in one piece.

Serge cartridges are hooped with blue worsted braid and choked with worsted; silk cloth cartridges are hooped with silk braid and choked with silk twist. All cartridges containing 20 lb. charges and upwards have a becket over the choker to enable them to be easily withdrawn from the cases. All cartridges for P. powder are marked both for P. powder and R.L.G., as shown in the drawing. When P. powder



§ 2108.

is used, the marking for R.L.G. is to be obliterated by lines of printers' ink and vice versâ when R.L.G. is used. When P. powder is not available the cartridges are to be filled with the authorised charges of R.L.G. and made up to the length given in the table, p. 113, by hooping the bags tightly, the diameter of the cartridges when filled with P. powder is $\frac{1}{2}$ " less than the calibre of the gun, while the diameter of the cartridge filled with R.L.G. is an inch less than the calibre down to the 10", and varies between an inch and half an inch less with the smaller guns.†

* Silk cloth or "amiantine" is woven from the coarse refuse silk fibre.

† L.G. powder may be used in lieu of R.L.G. for full or reduced charges of 30 lbs. and under, and in case of necessity for battering charges of 7", 8", and 9" guns.

The cartridges are divided into three classes—battering, full, and reduced; the terms are naval. The reduced charges are only used for saluting, and are made only for the 9", 8", and 7" guns, as the larger guns would not be used for saluting. The battering charges are used with Palliser projectiles, and the full for all other projectiles.

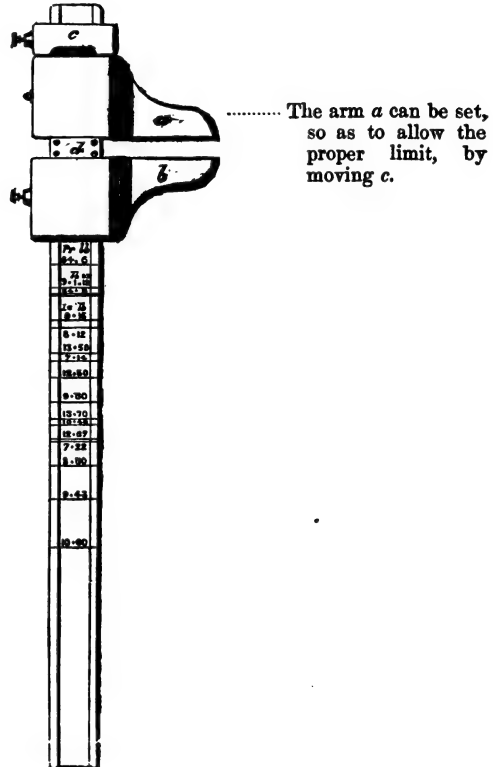
For details, *see* table, p. 113.

The 32-pr. S.B. 10 lbs. cartridge is used as a reduced charge for the 7".

Issue.

Empty, same as for S.B. cartridges, *vide* p. 47.

Gauge, Wood, Length, M.L. Cartridges.



Gauges.

§§ 2074, 2330.

A universal gauge has been provided for filled R.M.L. cartridges, having the lengths marked on one side and the diameters on the other. There is an arrangement enabling the proper limit to be given in measuring the length. Brass ring gauges are also used.

Drill cartridge.

§§ 2358, 2516.

Drill Cartridge.—Is made of a hollow wood block covered with hide, and the nature of gun and charge marked on it.

Issue.

Loose in numbers as demanded.

They are now made of the same size as P. powder cartridges.

CHAPTER XI. — AMMUNITION R.M.L. SHUNT SYSTEM, 64-PR. AND 80-PR. CONVERTED GUNS. 40-PR. AND 25-PR. GUNS.

THE manufacture of guns on the shunt system has ceased, and the only gun to which it is applied is the 64-pr. of 64 cwt., which is exclusively a naval gun. The ammunition used for the converted 64-pr. gun of 71 cwt.* (from 8" gun of 65 cwt.), also a naval gun, is exactly the same as that used for the shunt, though the rifling is not on the shunt principle. The calibres of the guns are very nearly the same, the shunt being 6"·3, and the converted gun 6"·29. The twist is 1 in 40 calibres in both guns.

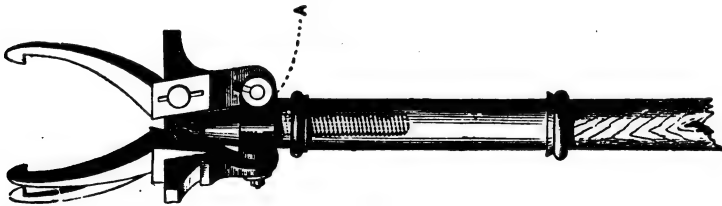
The shunt gun has a groove, which at the muzzle may be considered as made of two grooves, a shallow one towards the driving edge and a deeper one towards the loading edge; these two grooves run into one another about half-way down the bore, the shallow groove as it were shunting into the deep one. In loading, the stud follows the loading edge, keeping in the deep groove, but in coming out bears against the driving edge, shunting into the shallow groove. In this system the gun loads easily, but the shell is tightly gripped on coming out, the stud being slightly compressed; therefore a soft metal, copper without any tin, is used for the studs.

The shell for the 64-pr. may be known by their having three† studs to each groove instead of two like the other R.M.L. guns. For details of projectiles, *see* table, page 117.

Common Shell.—Gauge, G.S. Fuzes, Pettman G.S. percussion, or R.L. percussion, Mark II. Common shell. § 1768.

The mark showing the pattern of the shell will be found between an extractor hole and the row of studs.

The extractor holes are placed in prolongation of the row of studs. The extractor has three guides, which keep in the grooves and bring the



teeth of the jaws over the extractor holes; by turning the handle, the collar A. attached to the counter jaws recedes or advances, opening or closing the jaws by means of pins attached to the collar, which work in slots in the counter jaws.

Generally filled for S.S., marked in red with monogram of station Issue. and date of filling, fuzed with Pettman's G.S. fuze and issued loose. For L.S. would generally be issued empty, loose.

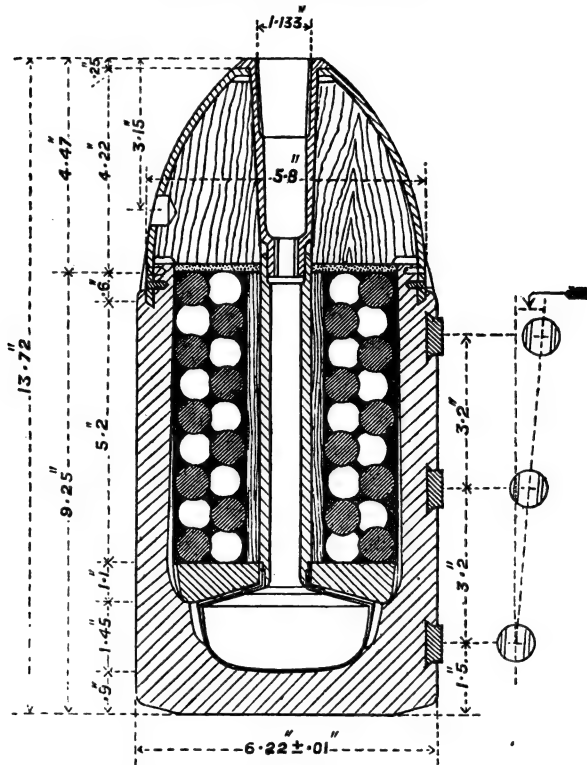
* A converted 64-pr. of 58 cwt. (from 32-pr. of 58 cwt.) is now introduced for the L.S.; it will take the same ammunition.

† Early patterns with five studs to each groove may still be met with.

Shrapnel shell.
§§ 2209, 2852.

Shrapnel Shell.—Gauge, G.S. Fuzes, 5 or 9 sec. M.L. These shells generally resemble the shrapnel for guns of higher calibres, but the balls are of mixed metal, and round the central tube is a thin wooden tube, which is introduced to fill up space and bring the shell to the proper length without unduly increasing the weight.

64-pr. Shrapnel Shell, Mark V.



‡ The projecting socket of shrapnel shell was found liable to injury in transit; it is now replaced by a socket flush with the head of the shell.

S.S. filled and boxed, primer fixed and marked as usual. Empty, loose for L.S.

Issue.
§ 2857.

Case shot.
§§ 2188, 2266,
2176, 2925.

Case Shot.—R.L. pattern, with six iron segments; like all M.L. case, it has no studs; iron handle in top. In latest pattern the top is stamped "64-pr. or 80-pr. M.L."

Issue.

Loose.

80-pr. projec-
tiles.

The 80-pr. gun of 5 tons, converted from 68-pr. of 95 cwt., is for L.S. only. The rifling has three grooves of the "Woolwich" form, but smaller than those for the heavier guns. Twist, 1 in 40 calibres, and uniform. Calibre same as 64-pr., i.e., 6"·29. The projectiles (excepting case) for this gun have two rings of studs made of copper with a little zinc added. The front stud is smaller than the rear one, to diminish the pressure needed to "swedge" the stud into the shell.

Common shell.
§ 2278.

Common Shell.—Gauge, G.S. Fuzes, Pettman G.S. or R.L., Mark II. This shell has a strengthening belt in the interior under the front row of studs. For details, see table, page 117.

Issue.

Empty, loose.

- Shrapnel shell.** *Shrapnel Shell.*—Gauge, G.S. Fuzes, 5 and 9 seconds M.L. This shell resembles that for the 64-pr., and, like it, has a wooden tube round the central tube. For details, *see* table, p. 117.
- § 2878.**
- Issue.** Empty, loose.
- Case shot.** The same case shot is used for the 64 and 80 pr. guns.
- 40-pr. projectiles.** The 40-pr. shells have two rings of gun-metal studs, three in each ring. They have no extractor holes.
- Common shell.** *Common Shell.*—Gauge, G.S. Fuzes, 9 and 20 seconds M.L., R.L. percussion, Mark II. This shell is bushed with gun metal but not countersunk. For details, *see* table, p. 117.
- § 2503.**
- Shrapnel shell.** *Shrapnel Shell.*—Gauge, G.S. Fuzes, 5 and 9 seconds M.L., R.L. percussion, Mark II. This shell has its head painted red. Its interior arrangements resemble those for the 64-pr. shell, but it has no wooden tube, and its central tube is smaller and fits into the gun-metal socket.
- § 2504.**
- Case shot.** For details, *see* table, p. 117.
- § 2479.** Of R.L. pattern. Iron handle on top. For details, *see* table, p. 117.
- 25-pr. projectiles.** The 25-pr. shell have two rings of studs, three in each ring.
- Common shell.** *Common Shell.*—Gauge, G.S. Fuzes, 9 and 20 seconds M.L., R.L. percussion, Mark II. This shell is unbushed. The studs are of gun metal. For details, *see* table, p. 117.
- § 2725.**
- Shrapnel.** *Shrapnel Shell.*—Gauge, G.S. Fuzes, 5 and 9 seconds M.L., R.L. percussion, Mark II. The latest pattern is cast to final dimensions instead of being turned. The studs are of copper. The interior arrangements resemble those described in the case of B.L. F.S. shrapnel, page 66, but has no weakening grooves. For details, *see* table, p. 117.
- § 2726.**
- Case shot.** R.L. pattern. Has an iron handle on top. For details, *see* page 117.
- § 2675.** The cartridges used with these guns will in future be of silk cloth, but the existing store of serge cartridges will be used up. The 32-pr. 10 lb. cartridge may be utilised for the R.M.L. 80-pr. 10 lb.* The 32-pr. 5 lb. silk cloth cartridge is available for 32-pr., 64-pr., or 80-pr. guns for use as a blank charge. The 32-pr. and 24-pr. 8 lb. cartridge and the 32-pr. 6 lb. cartridge are available for the 8 lb. and 6 lb. charges for the 64-pr. For details, *see* table, p. 114.
- Cartridges.**
- §§ 2177, 2759, 2838.**
- Issue.** The empty cartridges are made up in bales, similar to S.B., p. 47. For issue of filled cartridges, *see* p. 114.
- Drill cartridges.** Are hollow wood blocks covered with hide, and having crossed rope handles and an imitation choke, marked like service cartridges.
- § 2362.** *Extractor.*—The extractor for the 80-pr. is on the same principle as that for the Woolwich guns. *See* p. 85.
- §§ 2410, 2361.** Gauge, 80-pr. and 64-pr., iron ring, and cylinder.
- § 2537.** „ 40-pr. and 25-pr., „ body and studs.

* The 64-pr. will take 32-pr. ammunition. 32-pr. solid shot is fired from this gun at practice by the reserve forces, but 32-pr. case is not used with this gun, as it scores the bore. D. of A., vol. x., p. 169.

CHAPTER XII.—AMMUNITION FOR RIFLED M.L. FIELD GUNS.

THE French system of rifling has been adopted for the 16, 9, and 7 pr. R.M.L. field guns; the calibre of the 9 and 7 pr. guns is 3", the calibre of the 16-pr. is 3"·6. The bottom of the groove is concentric with the bore in the 7-pr., and eccentric in the 9 and 16 prs. The driving edge makes an angle of 70° with a radius to the centre of the bore, and the loading edge an angle of 56°. The result of this construction is that the projectile centres itself by running up the driving edge (*see* p. 75).

In this system the studs give both twist and direction, the body of the shell not touching the sides of the bore. The width of studs of 16 and 9 pr. shell has been reduced to 0·74" as some of the former pattern §§ 2098, 2104. were found to jam in loading. The width of the grooves is ·8".

In the 9-pr. gun the mean depth of groove is ·11", the mean projection of the stud is ·13", thus there is a mean clearance between body and bore of ·02" subject to reduction by manufacturing limits. Owing to the centring motion of the shell the clearance will be increased when the shell starts, the windage between the body and the bore being ·06", and when the shell centres there will be a clearance of ·03".

The twist is uniform, 1 in 30 calibres. The studs, two to each groove, are made of copper for all the shells of the 9-pr. and 7-pr., and for the shrapnel of the 16-pr. The 16-pr. common shell has gun-metal studs.

The studs for the 7-pr. are larger than the studs of the 9-pr., the twist is more rapid, 1 in 20 calibres, therefore the 7-pr. shell could not be fired out of the 9-pr. gun, though the calibre is the same.

The twist of the 16-pr. is 1 in 30 calibres, and consequently a little slower than in the other R.M.L. field guns. The same principle of studding has been carried out as in the 9-pr.; the clearance is the same in both guns.

The projectiles used for this system of rifling are common and shrapnel shell and case shot, also a double shell and a star shell for the 7-pr. gun.

The Common Shell for these guns are of G.S. gauge. Fuzes, 9 and 5 seconds M.L., Mark II. or III., R.L. percussion, Mark I. and II. (Mark I. is not to be used with the 16-pr. shells). These shells are not bushed.* For details, *see* table, p. 117.

(1.) Filled, G.S. wad inserted, plugged and boxed. Issue.

(2.) Empty, loose. For transport to India, empty, boxed.

The shrapnel shell resembles the B.L. F.S. shrapnel, except in being studded. Gauge, G.S. Fuzes, as for common shell. For details, *see* table, p. 117.

1. Filled, with primer, marked "Filled" in black on red head, plugged and boxed. Issue.

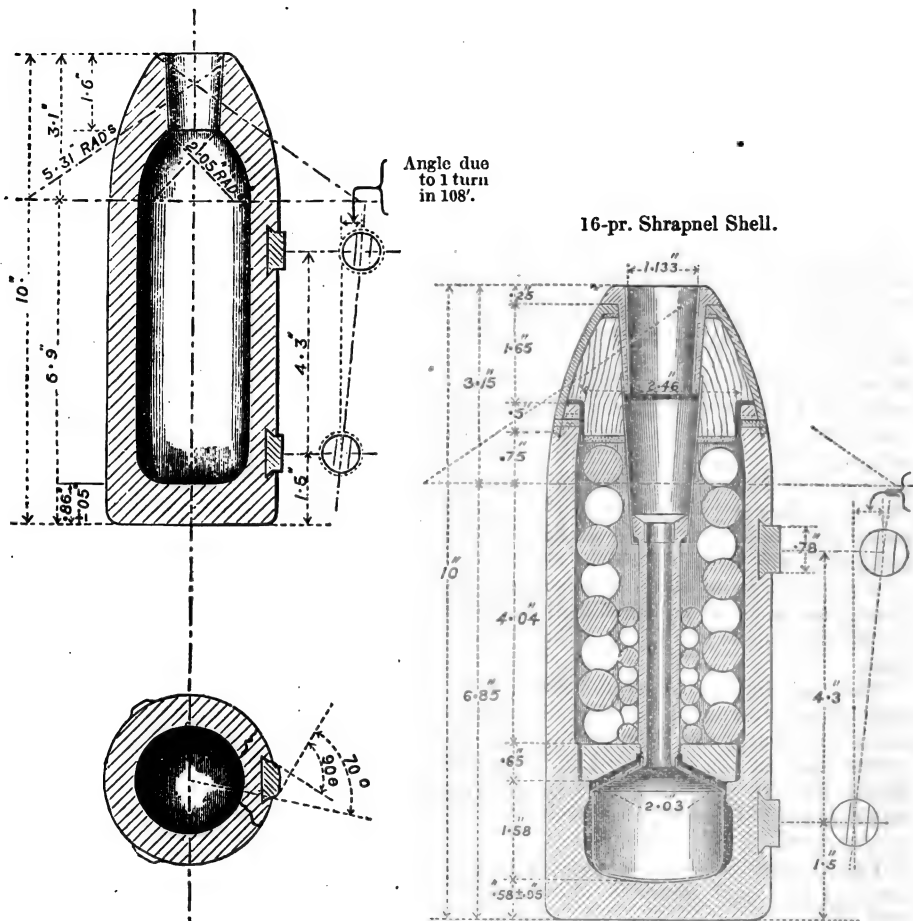
2. Empty, loose, with screw plugs. For transit to India, empty, boxed.

The 16-pr. shrapnel is now cast to final dimensions and has no weakening grooves. The 9-pr. has them in the base only, the 7-pr. in both body and base.

Of R.L. pattern. The 9-pr. has a tin top over a disc of wood. The 7-pr. has a plain tin top. For details, *see* table, p. 117.

In boxes. Issue.

* A G.S. plug with lanyard attached is issued for drill purposes.



Double shell.
§ 2097.

7-pr. Gauge, G.S. Fuzes, 9 or 20 seconds M.L., Mark II. or III.
This shell is used with a low charge (4 oz.) for high angle firing, its construction is generally similar to the common shell.

Issue.

Same as common shell.

Shell, R.M.L. Star, 7-pr.

§§ 2492, 2526.

A star shell has been sealed for the 7-pr. Gauge, G.S., slightly reduced so as to cause the fuze, 5 seconds, M.L., Mark II. or III., to project farther in order to ensure ignition with small charges. A kit plaster is placed over the head of the shell as a protection against damp. The shell has only one ring of copper, formerly zinc, studs, its head is made of tin lined with wood, and is lightly attached to the body with tacks and solder. The interior contains 13 stars made up in paper cylinders, about $2\frac{1}{2}$ inches long, composed of a composition consisting of nitrate of baryta, 9 lbs.; chlorate of potash, 6 lbs.; magnesium powder, 8 lbs.; boiled oil, $11\frac{1}{2}$ oz. These stars burn about 18 seconds. The burster, $\frac{1}{2}$ dram of R.F.G., is at the bottom of the shell; it is contained in a red shalloon bag and covered by an iron disc.

The flash from the fuze is conveyed by quick match to the burster, the stars are also ignited by quick match priming.

The shell has been fired at high angles, at 15° to 27° , and with from 4 oz. to 1 oz. of powder. Ranges of 400 to 600 yards have been obtained. It can be fired from the 9-pr., but is not included in the equipment.

To discover the enemy's operations at night.

In boxes, ready for use.

Use.

Issue.

Charges for the 16, 9, and 7 prs.

Charge, 3 lbs. There are two cartridges sealed for the service charges 16-pr. of this gun, one of serge, which will be used till the present supply of § 2212. serge is exhausted, and one of silk, which will then succeed the serge cartridge. A blank cartridge of silk has been sealed containing $1\frac{1}{2}$ lbs.; the two latter are choked and hooped with silk, the serge cartridge is choked with worsted and hooped with braid. For details, see table, p. 114.

Charge, 1 lb. 12 oz. The 9-pr. cartridge is made of serge, hooped 9-pr. with braid and choked with worsted or of silk, choked and hooped § 1921. with silk. A 1 lb. 8 oz. charge has been introduced for the 6 cwt. gun for SS.

A silk cartridge containing 1 lb. is used as a blank cartridge; it is § 2047. hooped and choked with silk.

The 7-pr. bronze gun of 200 lbs. has an 8 oz. charge; the 7-pr. steel 7-pr. gun of 150 lbs. a 6 oz. charge, and the 7-pr. steel gun of 200 lbs. a §§ 1414, 1471, 12 oz. charge. For all the guns there is a cartridge containing 4 oz. for 1781, also Cl. high angle firing with double shell and for star shell; made up in red 57, A.C. /72. shalloon to enable the choke to be small. The powder used for all 7-pr. cartridges is F.G. or R.F.G.

These cartridges, both filled and empty, are issued generally in the Issue. same manner as those for the smaller nature of smooth bores.

Drill cartridges of raw hide have been introduced for the 16, 9, and §§ 2088, 2435, 7 prs. 3093.

CHAPTER XIII.—ROCKETS.

THE only rockets at present in use as war rockets are the 24-pr. and 9-pr. of Hale's pattern. It is important to remember that Mark I. is unserviceable in case of its still existing at some out-station.

The head is of cast iron plugged with wood and riveted on to the Construction. body. The latter is of Atlas metal (a mild steel made by the Bessemer process) lined inside with brown paper and calico, the latter being inside the turns of the former. The object of this lining is to prevent the contact of the metal and the composition. The seam of the body it riveted together and brazed. The base is closed by an iron disc secured to the body by screws, and the disc is tapped to take the tail-piece. The tail-piece is of cast iron cupped out inside, and contains three conical vents, the larger part of the cone being towards the interior of the rocket. The vents are cut away on one side; and in consequence of this, the gas issuing from the vents meets with resistance on the side where the vents are prolonged, and, there being no counterbalancing resistance where the vents are cut away, rotation is given to the rocket. The tail-piece and vents are protected from injury, and the interior of the body from damp, by a covering of canvas secured by twine. Under the canvas is leather, to prevent the sharp edges of the tail-piece from cutting the canvas.

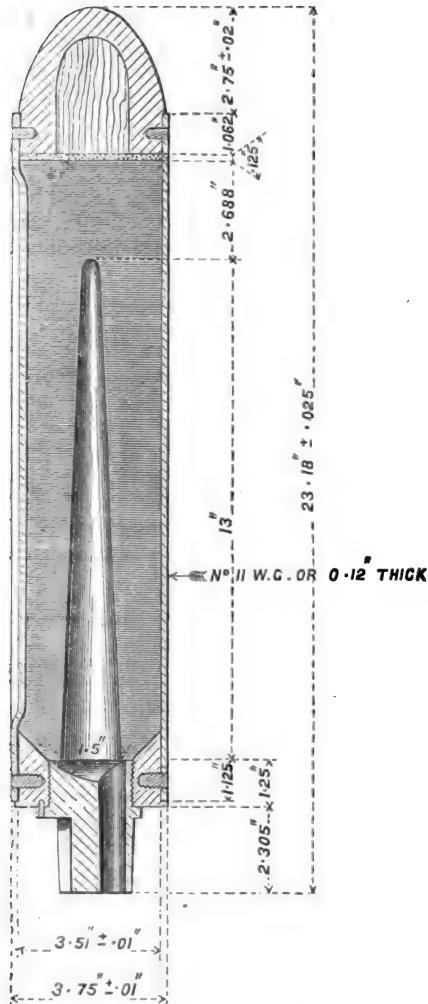
The composition consists of saltpetre, sulphur, and charcoal, mealed Composition.

and intimately mixed. It is pressed into pellets and driven into the rocket by hydraulic pressure. It is separated from the head by a mill-board disc, and is bored so as to expose a considerable amount of surface to ignition when the rocket is fired, as otherwise gas would not be formed rapidly enough to start the rocket.

Paint.

The whole of the rocket is painted red, and has its numeral and date stencilled on it in black.*

24-pr. Rocket, Mark IV.



The above description applies to the latest patterns of rockets, viz., 24-pr. Mark V., and 9-pr. Mark VI.

The earlier patterns have bodies painted inside and corrugated to prevent the composition from twisting away from the case, and have no paper lining. Up to Mark III. 24-pr. and Mark IV. 9-pr. the tail-pieces were not cupped out, and the cavity in the composition was smaller. The alteration has given about 300 yards increase of range,

* The numeral is also stamped on the base of the rocket. Each rocket, moreover, has a letter and number stamped on it.

owing to the larger surface exposed for ignition and the probable greater facilities for escape of slag. The earlier patterns have no canvas protection to the tail-pieces, the vents being merely closed with a piece of varnished paper.

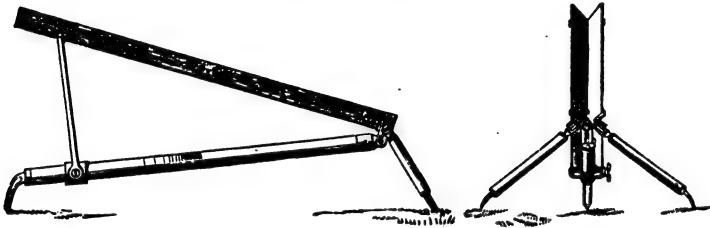
The reason generally given for the motion of the rocket is, that there is a greater pressure on the head than on the base owing to the gas escaping through the holes in the base, and therefore not acting on so large a surface.

The rocket is ignited by placing a friction tube in one of the vents, Firing. and firing it with a lanyard.

Any rockets showing rust about the case should be specially examined ; Effect of rust. if there is corrosion on the seams or joint the rocket is probably § 1881. dangerous, because the inside of the case may be rusty, and the flash will penetrate the porous rust, causing the composition to burn explosively. Mark II. to be specially inspected every quarter, and 3 per cent. sent to Woolwich from several large stations. The case is not painted on the inside, and is therefore liable to corrode. For examining, cleaning, and repainting, see § 2441.

Rockets are fired out of a trough, the construction of which is shown Rocket trough by the plate. There are two sizes, one for the 24-pr. and the other for §§ 1637, 1651. the 9-pr. Elevation is given by means of a bar, one end of which is fastened to the front of the trough, the other to a gun-metal ring which

Rocket Trough.



slides on the front leg, the scale is marked on the leg, the rings being brought to the required degree of elevation and clamped, 15° can be given with the 9-pr. machine, and 25° with the 24-pr. It is to be remarked that this method of giving elevation does not answer well unless the object aimed at is on the same plane as that on which the machine stands. In firing the rocket it will be found convenient to pass the lanyard under the foot to avoid upsetting the trough.*

Range.—Rockets are very uncertain both as to range and direction, the 24-pr. at 15° of elevation has been found to vary between †2,226 and 1,546 yards, while 9-prs. have ranged between 1,371 and 2,228 yards.

Use.—Rockets have been used for bombarding towns, firing shipping, buildings, &c. There is, however, no carcass rocket in the service. They have also been used against troops and are useful against cavalry, as they frighten the horses.‡

Rockets are issued in wood cases, that for 24-pr. holding 6,§ and that Issue. for the 9-pr. holding 12.

* A tube machine, Mark II., is used for the navy.

† Hale's rockets have been found to range longer with the wind from right to left than when it is in the contrary direction.

‡ War rockets are withdrawn from the equipment of fortresses, and will only be employed with siege trains and in the field as circumstances demand, Cl. 129, A.C. /72.

§ Will be superseded by a case holding three for S.S. See § 3058.

41989.

Signal rockets.

Signal Rockets.—Two sizes are made, 1 lb. and $\frac{1}{2}$ lb., they have paper cases, one central vent, and have a stick fastened on to a copper socket on one side to keep them end on during flight. In the head, stars and mealed powder are placed, dogwood charcoal is used in the composition to give a brighter tail to the rocket. They are fired by a portfire, the paper cap over the vent being removed to expose the priming.

Issue, 60 1 lb. rockets, and 84 $\frac{1}{2}$ lb. rockets, in special packing cases.

Rocket, 1 lb. and $\frac{1}{2}$ lb., issued to Board of Trade for display.

This kind of rocket has an arrangement by which it blows out its stick before it opens, to avoid danger when fired over the heads of crowds, the stick then falls horizontally instead of rocket and stick coming down together.

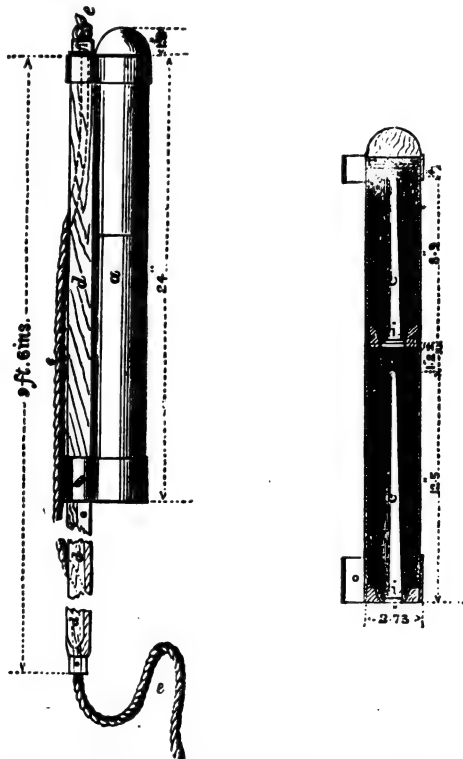
Issue.

In metal-lined cases and packing cases.

Signal rockets may be fired resting against a frame of any kind, or against a nail in a post. A tube is provided for firing them in boats, or in any place where the back rush of flame would be dangerous; in this case a quill friction tube is used.

Rocket, Boxer,
Life-saving,
12-pr.

Rocket, Life-saving.—Consists of a double rocket as shown in plate, the object being to keep up the velocity without causing too much of a strain upon the rope.



It is not issued to the R.A. at present, and to describe the arrangement fully would take up too much space. Its use is to carry a line to a stranded vessel, so as to establish communication with the shore. It is available to a distance of about 380 yards.

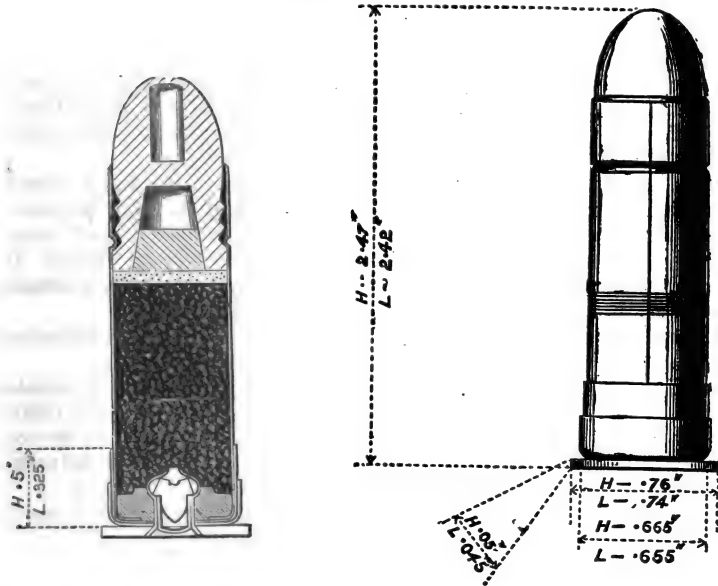
CHAPTER XIV.—SMALL ARM AMMUNITION. SNIDER AND MARTINI-HENRY RIFLES AND ADAMS' PISTOL.

THE same description of cartridge is used for all the B.L. small-arms with Snider action in the service; the same cartridge will fit an Enfield rifle or carbine, or Lancaster carbine. The diameter of the bore is $\cdot577''$, the diameter of the bullet is $\cdot573''$, small enough to drop through the bore, and, depending on expansion for its fit, the length of bullet is about $1''$ ($1\cdot04''$ in present pattern), and the length of the cartridge is a very little under $2\frac{1}{2}''$. The charge is 70 grs. (very nearly $2\frac{1}{2}$ drs.) of R.F.G. Each packet of ten rounds weighs about 1 lb.

Many patterns of this cartridge have been made, they are all serviceable with the exception of Mark I., which may be recognised by its having a potê base, formed by pressing out the rim of the base cup so as to form a beading round the edge instead of having a brass or iron base disc as the other marks have. Mark V. is a weaker* cartridge than the others, it may be recognised by its being the only brown paper covered cartridge without a distinguishing ring or rings marked on it. The brass sheet from which this cartridge is made is $\cdot003''$ thick, instead of $\cdot005''$ like the later patterns, and its base is not so strong as the earlier ones. The cartridge is not to be issued for foreign service, but is to be expended at home stations.

The sketch illustrates the construction of the present pattern of cartridge, which only differs in minor details from the other service patterns. Construction.

Cartridge, Snider Arm, Mark IX.



* The case has but one turn and an overlap of $\cdot3''$ of sheet brass; previous patterns have $2\frac{1}{2}$ turns of the same sheet brass.

The bullet is made from pure lead, weight 480 grs.; the hollow in the head is closed by having the lead spun over it, the hollow parts are necessary in order to get the bullet of a sufficient length for good shooting, without unduly increasing its weight, and to get its centre of gravity in the proper place; the hollow in the base is also used to give the expansive action to the bullets; the plug, made of clay, and soaked in beeswax, closes the rear cavity, and on firing expands the bullet, which has three cannelures; the sides of the bullet as far as the front cannelure are coated with beeswax, the cannelures holding a sufficient supply of the lubricant in their recesses; by the expansion of the bullet the lubricant is squeezed out, and the bore is thoroughly cleaned out by the bullets passing through it. As many as 4,000 rounds have been fired without fouling sufficiently to injure the shooting.

The case is formed of sheet brass covered with brown paper. It is lined with shellac and thin white paper to prevent corrosion from the powder. The case overlaps by about $\frac{1}{4}$ ", and is cemented together with shellac and glue. It is attached to the bullet by being choked into the rear cannelure; the base is strengthened by two cups, and the bottom closed by an iron disc; inside, a paper pellet is pressed against the bottom of the cartridge, a brass cap chamber pierced with a fire-hole passes through the base and rivets the bottom of the cartridge to the case, the top being bulged out over the paper pellet, and the base of the cap chamber being flanged to fit the recess in the iron base disc; the cap chamber holds a brass anvil, on the shoulders of which rests the copper cap, which is primed with cap composition (fulminate of mercury, sulphide of antimony, and chlorate of potash) and varnished. A little wool is placed over the powder to keep it from touching the bullet.

On firing, the cap composition is forced against the point of the anvil, and the flash reaches the charge through the hole in the chamber; the case unwinds, and being pressed firmly against the sides of the bore prevents the gas from escaping in the direction of the breech; after firing, the cartridge contracts to its original proportions, making extraction easy.

The base of the cartridge is very strong owing to its base cups and disc, and it is at the base that strength is essential, indeed if the base is perfect, a very faulty cartridge may be fired without throwing any undue strain on the breech.

The cartridge is found to stand rough usage and wet well; what tries it most is a moist hot climate,* it is almost impossible to prevent the moist air from penetrating when aided by great variations of temperature. Experiments have shown that it is impossible to explode these cartridges in a mass, thus firing $\frac{1}{4}$ lb. of powder along with a number of cartridges in an iron cylinder hardly exploded any rounds.

Marks.	The first four marks had the brass cylinder covered with white paper.	
§ 1328.	Mark	I. has a potê base, before described.
§ 1448.	"	II.† has a brass disc, and heavy bullet, 525 grs. 4 cannelures.
§ 1449.	"	III. has also a brass disc. The bullet is shorter (480 grs. weight), the distance therefore from choke to top of case is less, but it is hard to distinguish between II. and III. 3 cannelures.
§ 1450.	"	IV. is the only cartridge which has white paper and iron disc. Bullet has 3 saw-shaped cannelures.

* Much information as to the effect of climate on early patterns without paper lining will be found in Extracts, Vol. VII., p. 234.

† This cartridge is best suited for the naval rifle, as its long bullet, weight 525 grs., gives good shooting with the rapid twist of this rifle.

- Mark V. is the only brown paper cover cartridge without a distinguishing ring. Brass, .003" thick. 4 cannelures. \$ 1496.
- " VI. has one black ring. " .005" " " \$ 1703.
- " VII. has one black ring and lead spun over head instead of wood plug. Bullet, 4 cannelures. \$ 1760.
- " VIII. has two black rings, lined with tissue paper and shellac to prevent corrosion. \$ 1831.
- " IX. has one red ring; it only differs from VIII. in having a bullet with 3 cannelures of the same size as pattern IV., which was supposed to give better shooting at long ranges. \$ 2105.

In packets of 10 rounds, bullets all one way, made up in brown paper, *see* p. 52. Issue.

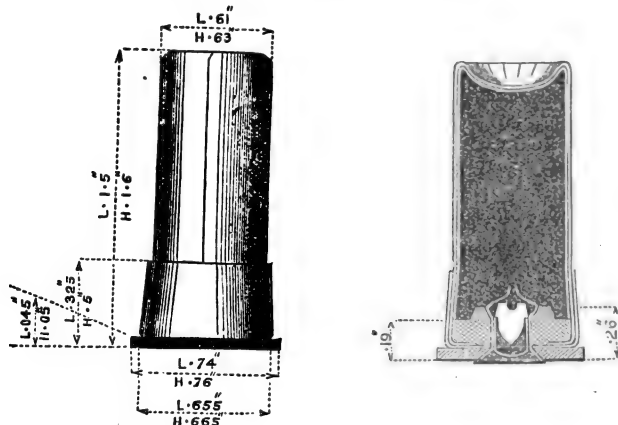
Blank Cartridges are issued in packets of 10 rounds, made up in purple paper, *see* p. 52. Blank cartridges for B.L. rifles.

Three patterns of blank ammunition may be met with; all are serviceable. §§ 1552, 2271.

- I. Obsolete. \$ 1451.
- II. The case is made of sheet brass not covered by paper, and contains the powder in the form of a pellet. \$ 1451.
- III. Differed from II. in having a paper case. \$ 1552.
- IV. Differs from III. in having the powder loose, and in some minor details of construction. \$ 2332.

Besides the above, a large quantity of blank is converted from condemned ball cartridge, either Snider or Martini-Henry, and is called "Blank, Mark IV., converted."

Mark IV. Blank Cartridge.



It is suited for either Snider or Martini-Henry rifles.

Buck shot cartridges. A special cartridge containing buck shot \$ 2546. has been issued to convict prisons; it is adapted for the Snider Enfield. Mark I. charge, in a pellet and shot embedded in plaster of Paris; II. charge, loose and shot in bone dust; the latter is far the most effective. It carries about 50 yards.

Ammunition for Adams' Revolver.

The cartridge consists of a small brass cylinder with the base attached \$ 1739. in the same way as the Boxer-Snider; the charge is 13 grains of pistol powder; there is no wool between the charge and the bullet; the bullet

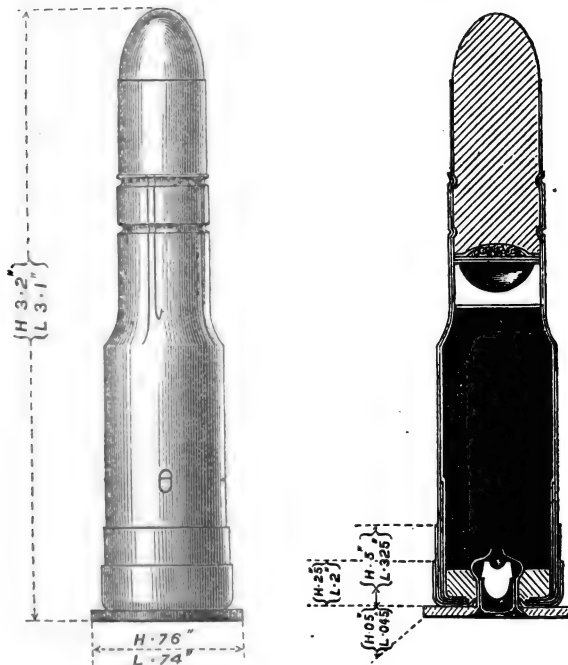
is pure lead weighing 225 grains, made up in bundles of 12 in brown paper wrappers. For packing, *see* page 53.

Martini-Henry Ammunition.

The bore of the Martini-Henry rifle is $\cdot 45''$; the bullet is made of lead hardened with tin, $1''\cdot 27$ long, weight 480 grs. (12 lead to 1 tin), its diameter increases from $\cdot 439''$ at the shoulder to $\cdot 45''$ at the base; the small hollow in the base of the bullet tends to expand it, and the great length of the bullet causes it to set up in the bore and fill the grooves; two cannellures allow the cartridge to be secured to the bullet by choking. The charge is 85 grs. of R.F.G².

In general construction the cartridge resembles the Snider; the sketch (*see cut*) shows its construction. The case consists of two

Martini-Henry Cartridge.



turns and an overlap of $\cdot 5''$ of $\cdot 004''$ brass, and in addition to the two base cups has a strip of brass $\cdot 004''$ thick inserted between the folds of the case at the base of the cartridge.* The cartridge is made of a bottle-necked shape by crimping in the upper part so as to make it fit into the short chamber of the rifle; before this change was made the cartridge was found to be inconveniently long. The bullet has two turns of fine white parchment paper wrapped round it from right to left and lubricated at the base for about half its length in beeswax; the object of the paper is to prevent leading, and it untwists in passing through the bore.

* To enable the examiner to see that this strip is in proper position, a small "sight-hole" is punched in the outer fold of the case, as shown in the cut.

Over the powder in the cartridge a cardboard disc is placed, then a wad of beeswax,* and then two more cardboard discs; the bullet is choked in the usual manner into the case; the cartridge is a little over 3" in length.

Packing.—In tens, packed heads and tails in brown paper; 10 rounds weigh a little over 1 lb. See page 52.

The only pattern likely to be met with is Mark III.; Marks I. and II. may be recognised by their having only one choke, instead of two.

The comparative accuracy of the Snider and Martini-Henry is shown by the figure of merit obtained in firing new ammunition from a fixed rest at a range of 500 yards; the figure of merit of the Snider is about 14", and that of the Martini-Henry about 9"; the latter having also the advantage of a flatter trajectory.

Two cartridges have been made for the Gatling guns, one for the '45 Gatling ammunition. bore, and one for the '65 bore.

The '45 cartridge is a solid case, at present procured by contract, lacquered inside, and containing the same powder charge, wads, and bullet as the Martini-Henry cartridge.

No anvil is used; the cap is fixed by being driven against a nipple in the base, pierced to allow the flash to pass into the charge.

It is packed 10 rounds in a packet, weighing about 1 lb. 2 oz.

The '65 cartridge is a coiled case, generally resembling the Martini-Henry cartridge. It contains 270 grs. R.F.G.² powder, and takes a bullet (of same alloy as the M.H. bullet) weighing 1,422 grs. (3½ oz.). It is packed 10 rounds in a packet, weighing about 3 lbs. 7 oz.

CHAPTER XV.—HINTS ON THE EXAMINATION OF AMMUNITION.

THE method of examining powder and its classification will be found in the Regulations for Gunpowder Magazines. The "flashing" test is a ready way to ascertain whether powder is of good quality and in good condition. About eight drams of powder are poured on a glass plate so as to form a conical heap and "flashed" by applying a hot iron; no residue should be left, only a few smoke marks should be seen on the plate.

If powder has been much damaged by damp it will be "caked," and a close inspection will generally detect a white appearance due to the saltpetre having been dissolved and deposited in crystals on the surface.

Examination of Cartridges.

The condition of the powder must be examined as above given. Owing to pressure, cartridges which have been tightly packed sometimes feel hard as if the powder was caked, in this case the powder will crumble into its proper condition when handled, and so cannot be confounded with powder which is "caked" from damp.

* The beeswax wad is hollowed out to ensure its expanding in cold weather.

The condition of the serge should be closely looked to, and any cartridges having holes or traces of being moth-eaten should be rejected. Silk cartridges should be examined in a similar manner; they are said to be much less liable to the attack of insects than serge.

The cartridges should be gauged, the choking and hooping should be looked to; the directions as to these operations have been given in the notes. Specially see that the silk cartridges are choked and hooped with silk, and that blank cartridges for B.L. guns are choked with worsted, and service cartridges for B.L. guns with twine. The knots of cartridges for rifled guns require careful examination, as often a slip knot is made instead of a fast one.

Proof of Friction Tubes.

See Instructions for Proof of Tubes, &c. given in the Appendix, p. 125.

Care should be taken to keep the vents clear, and to ensure their being free from damp a tube should be fired before commencing to test.

Proof of primers for shrapnel shell. *See Instructions in Appendix, p. 125.*

The proof of primers for vent-pieces, and of fuzes, both time and percussion, will be found in the Instructions. It is well to gauge the time-fuzes as the wood sometimes alters its form; in the case of fuzes of the common gauge having powder channels this is important, as sometimes they are so much enlarged as to bring the side holes above the fuze-hole. This can hardly happen with the fuzes of G.S. gauge.

Lights, portfires, &c. can be readily examined by burning, and ascertaining that they burn about the time laid down; if they burn well there is no harm in their burning long.

The primers for lights can be tested at the same time.

Examination of Projectiles.

All projectiles are examined by gauging. S.B. projectiles are so simple, and are so well known in the service, that it is not necessary to give any rules.

Lead-coated projectiles should be carefully examined as to the attachment of the lead coatings; in very bad cases the eye will detect a loose coat; and in doubtful cases, tapping the shell with a hammer will detect a loose place, as a peculiar dull sound is given out. The high ring gauge should be passed over the shell, and the lead, if set up, can be filed down.

If blisters appear on the surface, they should be pricked and the lead hammered down.

The fuze-hole of shell of garrison calibres should be examined, and any having the Moorsom gauge must be converted by using a G.S. adapter.

The Moorsom gauge is readily known by the large plug with a shoulder and cylindrical body.

The adapter is screwed into its place by the "Key, fuze and plug, G.S."; when screwed home, it fits well down in the socket, about 2" below the top of the fuze-hole. The space between the side of the adapter and the iron of the shell is filled by a composition of rosin, 12 lbs.; Spanish brown, 2 lbs.; plaster of Paris, 1 lb.; turpentine, half a pint. The composition is poured in hot, the adapter being closed with a wooden plug.

In examining shrapnel shell, R.M.L. or B.L., special attention should be paid to the junction between the head and the body ; loose heads may be met with, especially in F.S. shrapnel of early patterns. A loose head renders the shell unserviceable ; also early patterns should be examined to see whether any rosin has worked up into the socket which would prevent the action of the fuze.

Studded projectiles should be examined by passing the cylinder gauge over them. As this gauge is slightly smaller than the calibre of the gun, a shot which passes the gauge is certain to load easily.

In examining common shell, M.L. or B.L., the condition of the lacquer should be looked to, and also as to whether any loose iron filings may be present in the shell. B.L. shell, with black lacquer, may occasionally be found and prematures may occur when using them. Any loose matter may be detected by "upending" the shell.

Proceedings
of O.S.C.,
Vol. III.,
pp. 143-240.

Palliser projectiles are sometimes damaged in transit ; if the point is broken off the shell becomes unserviceable. They can, however, be utilised at practice.* Any Palliser shot having the base closed with a wedge of wrought iron must be returned for repair as directed in §2040. All made prior to 1870 require alteration.

See §1872 for the patterns which do not require alteration.

Case shot are sometimes damaged in transit, or by the jolting motion of a limber. They can generally be repaired by a tinsmith, a little solder is often all that is wanting.

Shell that have been stored in the open air are sometimes found to have admitted water ; they should be carefully dried.

Nothing requires more care than the examination of shell returned into store as empty ; frequent accidents have happened from the presence of powder in shell so returned ; they are therefore received into store as *doubtful* and carefully examined. At out-stations shell so examined are marked with an E. in red.

Cl. 143, paras.
32, 33, 34,
A.C./69.

When it is necessary to break up old shell it may be done by placing an iron wedge in the fuze-hole and striking it with a sledge hammer. Shell should be washed out with water before this is done.

It is important to remember that projectiles which are not fit for service may often be used for practice ; thus shell may sometimes be found so damaged about the bush as to be unfit to use with a fuze, but they can be fired at practice as plugged shell.

B.L.S.A. ammunition. By opening the cartridge the state of the powder and the condition of the brass case can be ascertained.

B.L.S. arm
ammunition.
Examination.

In some of the early patterns, especially in Mark V., the brass may be found to be corroded by the action of the saltpetre on the metal.

The condition of the bullets as to dents and corrosion is rarely important ; a bullet may be much knocked about, and still will be found to shoot well.

Firing some "targets" from a rest will determine whether the cartridges are serviceable.†

B.L.S.A. ammunition is not to be condemned without the order of the Surveyor-General.

* See Army Circ., clause 34, 1877.

† By firing a target is meant firing a certain number of rounds, generally 20, at a target, taking a diagram of the shots, and thence estimating the shooting of the ammunition.

The Snider cartridge should be condemned if it gives a figure of merit over 20 inches when fired at 500 yards in fine calm weather from a fixed rest. Where no mechanical rests are provided, a good marksman using a sand bag will be able to fire with sufficient accuracy to test the ammunition.

The Martini-Henry should shoot about five inches better than the Snider.

Missfires are an important defect and should be reported.

**Breaking up
small arm
ammunition.**

Breaking up B.L.S.A. ammunition is an operation requiring great care; the cartridge should be opened with a copper tool, and the powder at once placed in water; on no account should any accumulation of loose powder be allowed on the table.

It is necessary to stir the powder to prevent its floating on the top of the water. In order to prevent risk in transit, the empty cases should be boiled to destroy the cap composition and the powder which is apt to stick to the cases.

**Hale's rockets.
Examination.**

Hale's rockets should be examined carefully and frequently for rust, especially along the seam and rivets; if the slightest trace is found, the rockets are to be repainted; full directions will be found in § 2441.

If rockets are very rusty they are probably dangerous, and should be returned to Woolwich. As before pointed out, Mark I. is unserviceable.

APPENDIX.

TABLE OF COMBUSTIBLE COMPOSITIONS FOR LABORATORY STORES.

1.—Carass Composition :— Saltpetre, ground - - - 6 4 Sulphur, ground - - - 2 8 Rosin, powdered - - - 1 14 Antimony, Sulphide of - - 0 10 Tallow, Russian - - - 0 10 Turpentine, Venice - - - 0 10	7.—Composition for Electric Tubes and Fuzes :— Copper, Sub-sulphide of. Copper, Sub-phosphate of. Potash, Chlorate of.	14.—Signal Light, Magnesium :— Saltpetre, ground - - - 14 Sulphur, sublimed - - - 34 Orpiment, red - - - 1 Magnesium, containing 25 per cent. of Paraffin - - - 04	19.—Detonating Composition for Boxes 5, 9, and 20 seconds Time-Fuze, B.L.R.O. :— Potash, Chlorate of - - - Parts. Antimony, Sulphide of - - - 6 Mercury, Fulminate of - - - 4 Damped with varnish of spirits, methylated, 1 pint, shellac 645 grains, in the proportion of 24 minims to 100 grains of composition.
2.—Ground Light Ball :— Saltpetre, ground - - - 6 4 0 Rosin, powdered - - - 2 8 0 Oil, Linseed, boiled - - - 1 14 0 Oil, Linseed, boiled - - - 0 7 8	8.—Common Portfire :— Saltpetre, ground - - - lb. oz. Sulphur, sublimed - - - 6 0 Powder, meal, cylinder - - - 2 0 Powder, meal, cylinder - - - 1 4	15.—Slow Match :— Hemp, Yarn, pure, Russian lb. 100 Ashes, Wood - - - bushel 1 Water - - - - galls, 50	20.—Detonating Composition for Percussion Caps. E. Time, K.L. and B.L. plain Percussion Fuze :— Mercury, Fulminate of - - - lb. oz. Potash, Chlorate of - - - 0 6 Antimony, Sulphide of - - - 0 4
3.—Parachute Light Ball :— Saltpetre, ground - - - lb. oz. Sulphur, sublimed - - - 7 0 Orpiment, red - - - 1 2 Orpiment, red - - - 0 11	9.—Blue, or Slow Portfire :— Water, distilled, from one to two quarts, according to the nature of the paper. Saltpetre, ground - - - lb. oz. Saltpetre, ground - - - 0 8	16.—Quick match :— Cotton Wick - - - 4 Gum, Arabic - - - 10 Powder, meal, cylinder - - - 2 2 Water, distilled 8 pts. 9 pta. 10 pta.	21.—Hale Rocket :— Saltpetre, ground - - - 24 P.R. Sulphur, sublimed - - - Parts. Charcoal, Alder, } - 70 8 75 ground. } - 18 2 0 } - 23 2 5
4.—Smoke Ball :— Powder, L.G., bruised - - - lb. oz. Saltpetre, pulverized by evaporation - - - 5 0 Coal, Sea, powdered - - - 1 0 Pitch, Swedish - - - 1 8 Tallow, Russian - - - 2 0 Tallow, Russian - - - 0 8	10.—Miners' Portfire :— Saltpetre, ground - - - lb. oz. Sulphur, sublimed - - - 4 0 Powder, meal, cylinder - - - 2 0 Powder, meal, cylinder - - - 2 0	17.—Fuze Composition :— Saltpetre, ground - - - lb. oz. Sulphur, sublimed - - - 3 4 Powder, meal, pit - - - 1 0 Powder, meal, pit - - - 2 12	22.—Signal Rocket Composition :— Saltpetre, ground - - - lb. oz. Sulphur, sublimed - - - 8 0 Charcoal, Dogwood - - - 2 0 - - - 3 0
5.—Detonating Composition for Copper Friction Tube :— Potash, Chlorate of - - - lb. oz. Antimony, Sulphide of - - - 0 6 Sulphur, sublimed - - - 0 6 Damped with spirits, methylated, 1 quart, shellac 824 grains, in the proportion of 200 minims to 1,000 grains of composition.	11.—Slow-burning Composition for Life-buoy Portfire :— Saltpetre, ground - - - lb. oz. Sulphur, ground - - - 8 0 Powder, meal, cylinder - - - 4 0 Powder, meal, cylinder - - - 1 0	18.—Detonating Composition for Pettman Percussion Fuzes :— Potash, Chlorate of - - - Parts. Antimony, Sulphide of - - - 13 Sulphur, sublimed - - - 13 Powder, meal, L.G. - - - 1 Damped with varnish of spirits, methylated, 1 pint, shellac 112 grains, in the proportion of 40 minims to 100 grains of composition.	23.—Composition for Stars of Signal Rocket :— Saltpetre, pulverized - - - lb. oz. Sulphur, sublimed - - - 8 0 Antimony, Sulphide of - - - 2 0 Isinglass - - - 0 34 Spirits, methylated - - - pint 1 Vinegar - - - quart 1 Powder, L.G. meal, } lb. 1 oz. 0 for priming - - - }
6.—Detonating Composition for Quill Friction Tube :— Potash, Chlorate of - - - lb. oz. Antimony, Sulphide of - - - 0 6 Sulphur, sublimed - - - 0 6 Powder, meal - - - 0 04 Glass, ground - - - 0 04 Damped with spirits, methylated, 1 quart, shellac 446 grains, in the proportion of 200 minims to 1,000 grains of composition.	12.—Quick-burning Composition for Life-buoy Portfire :— Saltpetre, ground - - - lb. oz. Sulphur, sublimed - - - 3 0 Powder, meal, pit - - - 1 0 Powder, meal, pit - - - 1 0	13.—Long and Coast Guard Lights, and Lights for Wrecks :— Saltpetre, ground - - - lb. oz. Sulphur, sublimed - - - 7 0 Orpiment, red - - - 1 12 Orpiment, red - - - 0 8	

* Distilled sulphur will be used in future manufacture.

TABLE OF FILLED CANNON CARTRIDGES.—SMOOTH-BORE.

NATURE.	Charge. — L.G. Powder.	Dia- meter of Car- tridge Body.	Dia- meter of Ring Gauge.	Length of Cartridge.		Number of Hoops.		Number Packed and Weight of Package.													
								Barrel, Whole.				Ammu- nition Box.		Case, Powder, Copper-lined.							
								Braid.		Worsted.		Number.		Weight.		Whole.		Half.		Quarter.	
								From	To												
100-pr.	-	-	-	{	in. 13.5 12.0 8.0	in. 14.5 12.5 8.5	3 2 1	— — —	3 4 7	lb. 109 115 119	1 2 4	lb. 47 62 70	8 4 9	lb. 134 129 138	— — —	— — —	lb. — — —				
10-inch	-	-	-	{	8.5 7.0	— —	— —	3 1	7 13	lb. 119 132	4 5	lb. 70 63	9 14	lb. 153 162	— 78	— —	lb. — —				
8-inch	-	-	-	{	10.2 9.2 —	— — —	— — —	3 2 —	9 12	lb. 125 132	4 5	lb. 62 63	11 14	lb. 100 102	70 78	— —	lb. — —				
68-pr.	-	-	-	{	12.8 11.5 9.5 7.4	— — — —	— — — —	3 3 2 1	5 6 8 12	lb. 125 131 132 132	2 3 4 5	lb. 58 70 70 63	6 6 9 14	lb. 153 145 158 102	— — — —	— — — —	lb. — — —				
56-pr.	-	-	-	{	11.6 —	— —	— —	3 —	6 —	lb. 119	3 —	lb. 65	8 —	lb. 161	71	— —	lb. — —				
42-pr.	-	-	-	{	12.3 11.2 10.2 —	— — — —	— — — —	3 3 3 —	6 8 9 —	lb. 119 132 130	3 4 4 —	lb. 65 70 64	8 9 11	lb. 161 158 164	71 78 72	— — —	lb. — —				

Table of Filled Cannon Cartridges.—Smooth-bore—continued.

NATURE.	Charge. — L.G. Powder.	Dia- meter of Car- tridge Body.	Dia- meter of Ring Gauge.	Length of Cartridge.		Number of Hoops.	Number Packed and Weight of Package.										
							Barrel, Whole.		Ammu- nition Box.		Whole.		Half.		Quarter.		
From		To		Braid.	Worsted.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.				
in.	in.																
32-pr.	- - - - -	in. 6.00 6.00 6.00 6.00 5.8	in. 6.00 6.00 6.00 6.00 5.8	10.75	in.	—	3	9	lb. 125	4	lb. 63	11	lb. 160	4	lb. 70	—	lb. —
				9.2	—	—	2	12	132	5	72	13	162	6	78	—	—
				8.0	—	—	2	13	126	7	81	16	162	7	78	—	—
				7.5	—	—	2	16	120	8	71	18	164	8	78	—	—
				6.5	—	—	1	19	130	10	73	22	160	10	80	—	—
24-pr.	- - - - -	in. 5.52 5.52 5.52 5.2	in. 5.52 5.52 5.52 5.2	10.5	—	—	3	12	131	5	63	14	162	6	78	—	lb. —
				8.3	—	—	2	16	131	8	71	19	164	8	78	—	—
				6.5	—	—	2	25	136	12	71	27	158	13	82	—	—
				5.2	—	—	1	32	132	18	77	37	161	17	81	—	—
				9.0	—	—	3	16	131	8	71	19	164	8	78	—	—
12-pr.	- - - - -	in. 4.35 4.35 4.35 4.3	in. 4.35 4.35 4.35 4.3	9.0	—	—	3	16	131	8	71	19	164	8	78	—	lb. —
				5.75	—	—	1	32	132	18	77	37	161	17	81	—	—
				8.6	—	—	3	25	136	12	71	27	158	13	82	—	—
				6.0	—	—	2	37	130	18	69	44	161	20	81	—	—
				8.2	—	—	3	32	132	18	77	37	161	17	81	—	—
9-pr.	- - - - -	in. 3.9 3.9 3.8 3.8	in. 3.9 3.9 3.8 3.8	6.7	—	—	2	38	132	18	69	44	161	20	81	—	lb. —
				4.9	—	—	1	58	124	30	69	74	162	35	83	—	—
				8.2	—	—	3	32	132	18	77	37	161	17	81	—	—
				6.7	—	—	2	38	132	18	69	44	161	20	81	—	—
				4.9	—	—	1	58	124	30	69	74	162	35	83	—	—
6-pr.	- - - - -	in. 3.35 3.35 3.35 3.35	in. 3.35 3.35 3.35 3.35	5.5	—	—	2	58	124	30	69	74	162	35	83	—	lb. —
				4.4	—	—	1	94	134	42	63	110	162	50	81	—	—
				8.2	—	—	3	32	132	18	77	37	161	17	81	—	—
				6.7	—	—	2	38	132	18	69	44	161	20	81	—	—
				4.9	—	—	1	58	124	30	69	74	162	35	83	—	—

Table of Filled Cannon Cartridges.—Smooth-bore—continued.

NATURE.	Charge. — L.G. Powder.	Dia- meter of Car- tridge Body.	Dia- meter of Ring Gauge.	Length of Cartridge.		Number of Hoops.		Number Packed and Weight of Package.							
								Barrel, Whole.	Ammu- nition Box.		Case, Powder, Copper-lined.				
									Weight.	Number.	Whole.	Half.	Quarter.		
				From	To	Braid.	Worsted.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.
13-inch mortar	20 0	in. 8.35	in. —	12.75	in. —	—	3	4	lb. 115	2	lb. 82	—	—	—	—
	16 0	8.2	—	12.0	—	—	3	5	116	3	70	—	—	—	—
	9 0	7.85	—	7.3	—	—	1	10	125	6	146	—	—	—	—
10-inch "	9 8	6.5	—	9.7	—	—	3	10	131	4	60	12	71	5	78
	4 0	6.0	—	5.5	—	—	1	25	136	12	71	27	153	13	82
8-inch "	2 0	4.9	—	5.0	—	—	1	43	133	24	72	55	161	25	81
	0 7	3.1	—	3.1	—	—	1	220	135	120	77	240	157	120	84
44-inch "	0 5	2.6	—	2.9	—	—	1	260	122	160	76	300	147	160	82
	7 0	7.15	7.76	6.3	—	—	1	13	133	7	72	16	162	7	78
10-inch howitzer	4 0	6.25	7.76	5.3	—	—	1	25	136	12	71	27	153	13	82
	4 0	5.75	6.67	6.0	—	—	1	25	136	12	71	27	153	13	82
8-inch "	3 0	5.2	6.67	5.1	—	—	1	32	132	18	77	37	161	17	81
	2 0	4.15	5.1	5.2	—	—	1	43	133	24	72	55	161	25	81
54-inch "	0 8	2.2	2.2	4.6	—	—	1	200	136	110	78	230	167	110	86
	0 4	2.2	2.2	3.5	—	—	1	350	126	180	70	400	154	200	83
44-inch "	3 0	4.3	4.39	6.8	—	—	2	32	132	18	77	37	161	17	81
	2 0	4.3	4.39	5.4	—	—	1	43	133	24	72	55	161	25	81

Table of Filled Cannon Cartridges.—Smooth-bore—continued.

NATURE.	Charge. — L.G. Powder.	Dia- meter of Cart- ridge Body.	Dia- meter of Ring Gauge.	Length of Cartridge.		Number of Hoops.		Barrel, Whole.		Ammu- nition Box.		Number Packed and Weight of Package.			
												Whole.		Half.	
												Number.	Weight.	Number.	Weight.
				From	To	Braid.	Worsted.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.
24-pr. howitzer	lb. oz. 2 8 1 3	in. 4.76 4.2	in. 5.1 5.1	in. 5.6 4.6	in. — —	— — —	1 1 —	37 53 134	lb. 130 134	18 30 80	60 69 74	44 74 74	lb. 161 162	20 35 35	lb. 81 83
12-pr. "	2 0 1 4 1 0	3.9 3.6 3.4	4.2 4.2 4.2	6.3 5.3 4.5	— — —	— — —	2 1 1	43 77 94	133 134 134	24 38 42	72 71 65	55 88 110	161 161 162	25 40 50	81 81 81
68-pr. carronade	5 0	6.3	—	6.3	—	—	1	10	130	10	73	22	100	10	80
42-pr. "	3 8	5.7	—	5.3	—	—	1	27	131	13	69	32	163	14	79
32-pr. "	2 11	5.15	—	5.2	—	—	1	33	136	18	73	42	164	18	79
24-pr. "	2 0	4.7	—	4.6	—	—	1	43	133	24	72	55	161	25	81
18-pr. "	1 8	4.1	—	4.4	—	—	1	58	134	30	69	74	162	35	83
12-pr. "	1 0	3.8	—	3.4	—	—	1	94	134	42	65	110	162	50	81
6-pr. "	0 10	3.1	—	3.4	—	—	1	130	121	72	69	160	153	72	76
Bags, { Rifle L.G. L.G. 15 lb. { F.G.	— — —	— — —	— — —	— — —	— — —	— — —	— — —	8 8 7	155 155 140	4 4 4	83 83 83	8 4 8	170 170 170	4 4 4	90 90 90

Exercise L.G. or R.L.G. is used for blank charges.

The pentagon, rectangular plain, and various sizes of corrugated brass cases might also be used to contain the S.B. cartridges; but as these cases are for naval purposes, and the S.B. ordnance has practically disappeared from the navy, it has not been thought necessary to give the numbers of cartridges that might be contained in these cases.

TABLE OF FILLED CANNON CARTRIDGES.—B.L. RIFLED ORDNANCE.

Number Packed and Weight of Package in Pounds.																			
Cases, Powder.																			
Nature,	Description.	Charge.	Length.	Diameter.	Paper Cylinder.		No. and Nature of Braid Hoops.	Copper-lined.						Metal or Brass.					
					Length.	Diameter.		Whole.		Half.		Quarter.		Whole.		Sectional.		Rectangular.	
								Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.
7-inch	Full, I.	11* L.G.	Inches.	Inches.	Ins.	Narrow													
	Blank, I.	10 1/4 "	10 to 11	7 03	4 5	3 25	5												
40-pr.	Full, I.	7 "	10 " 6 5	"	"	4 1	2												
	Blank, I.	6 "	10 " 6 5	4 77	4 5	3 25	2												
20-pr.	Full, I.	5 "	10 " 6 5	"	"	"	6												
	Blank, I.	4 1/2 "	12 25 " 12 75	"	"	"	2												
12-pr.	Full, I.	3 1/4 "	6 75 " 10 75	3 77	4 25	2 5	2												
	Blank, I.	1 1/4 "	4 75 " 5 25	"	"	"	2												
9-pr.	Full, I.	1 1/4 "	8 " 8 5	3 02	"	"	4												
	Blank, I.	1 "	6 " 6 5	3 07	"	"	3												
12 or 9 pr.	Full, I.	1 "	8 25	3 125 & 2 87	"	"	6												
	Blank, I.	10 oz.	6 25 " 6 5	2 53	"	"	3												
6-pr.	Full, I.	10 oz.	6 25 " 6 5	"	"	"	3												
	Blank, I.	10 oz.	6 25 " 6 5	"	"	"	3												

* For 7-inch, 82 cwt.

Exercise L.G. or B.L.G. is used for Blank.

† For 7-inch, 72 cwt.

B, C, D, E, and F corrugated cases may also be used for packing these cartridges.

‡ With paper covers.

Table of Filled Cannon Cartridges.—R.M.L. Ordnance—continued.

Number Packed and Weight of Package in Pounds.																															
Cases, Powder.													Metal or Brass.																		
Nature.	Description.	Charge.	Length.	Diameter.		No. and Description of Hoops.	Copper-lined.						Pentagon.			Rectangular.															
				Body.			Bottom.		Whole.	Half.	Quarter.		Whole.	Sec- tional.	Plain.	A	B	C	D	E	F										
				Ins.	Inch.		Ins.	Ins.			Number.	Weight.										Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.
7-inch	Battering, I.	30 "P."	29.5 to 32.5	6.5	5.57	12 narrow	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Full, I.	22 R.L.G.	18.5 " 19.5	6.4	"	"	5 159	3 72	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Reduced, I.	14 "	13.5 " 14.5	"	"	"	7 148	4 71	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8" how.	Service, I.	10 L.G.	9.25 " 9.75	6.8	—	—	11 160	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	"	5 "	8.75 " 9.25	6.3	—	—	11 162	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	"	2 1/2 "	5.75 " 6.25	6.0	—	—	21 158	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
80-pr.	Service, I.	10 "	11.25 " 11.75	6	—	—	41 157	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
64-pr.	Service, I.	8 "	9.2 " 9.7	6	—	—	11 160	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
40-pr.	Reduced, I.	6 "	7.5 " 8.5	6	—	—	14 162	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Service, I.	7 "	13.75 " 14.75	4.3	—	—	19 164	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Blank.	—	—	—	—	—	16 162	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
25-pr.	Service, I.	4 R.L.G.	10.75 " 11.25	3.6	—	—	26 157	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16-pr.	Service, I.	3 "	9.5 " 10.0	3.3	—	—	30 143	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9-pr.	Exercise, I.	1 1/2 "	5.5 " 6.0	3	—	—	60 159	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Service, I.	1 1/2 "	9 " 9.5	5	2 5/16 to 2 6/16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Exercise, I.	1 1/2 "	8.25 " 8.75	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7-pr.	Service, I.	12 oz. F.G.	5.7 " 6.25	2.5	—	—	100 153	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Exercise, I.	1 "	5.75 " 6.25	2.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Service, I.	8 oz. "	4.5 "	2.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
15 lb. bags	Exercise, I.	6 oz. "	3.5 "	2.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Exercise, I.	4 oz. "	2.7 "	2.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Exercise, I.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Weight of package empty	Exercise, I.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Exercise, I.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Exercise, I.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

N.B.—L.G. powder is used in the L.S. for full charges with R.M.L. garrison guns under 10".

Exercise L.G. or R.L.G. is used for exercise, or saluting charges, and the reduced charges for 7", 8", and 9" R.M.L. guns.

* With paper covers.

TABLE OF FILLED CANNON CARTRIDGES.—SMOOTH-BORE.

NATURE.	Charge. — L.G. Powder.	Dia- meter of Car- tridge Body.	Dia- meter of Ring Gauge.	Length of Cartridge.		Number of Hoops.		Number Packed and Weight of Package.											
								Barrel, Whole.				Ammu- nition Box.		Whole.		Half.		Quarter.	
								From	To	Braid.	Worstcd.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.
				From	To	Braid.	Worstcd.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.				
100-pr.	-	-	-	in. 13.5 12.0 8.0	in. 14.5 12.5 8.5	3 2 1	—	3 4 7	lb. 109 115 119	1 2 4	lb. 47 62 70	3 4 9	lb. 134 129 133	—	—	—	lb. —		
10-inch	-	-	-	8.5 7.0	—	—	3 1	7 12	lb. 119 132	4 5	lb. 70 63	9 14	lb. 133 162	6	78	—	lb. —		
8-inch	-	-	-	10.2 9.2 —	—	—	3 2	9 12	lb. 125 132	4 5	lb. 62 63	11 14	lb. 100 162	4 6	70 78	—	lb. —		
68-pr.	-	-	-	12.8 11.5 9.5 7.4	—	—	3 3 2 1	5 6 8 12	lb. 125 131 132 132	2 3 4 5	lb. 58 70 70 63	6 6 9 14	lb. 133 145 138 102	2 2 3 6	62 73 78	—	lb. —		
56-pr.	-	-	-	11.6 —	—	—	3	6	lb. 119	3	lb. 65	8	lb. 161	3	71	—	lb. —		
42-pr.	-	-	-	12.3 11.2 10.2 —	—	—	3 3 3	6 8 9	lb. 119 132 130	3 4 4	lb. 65 70 64	8 9 11	lb. 161 133 164	3 4 4	71 78 72	—	lb. —		

Table of Filled Cannon Cartridges.—Smooth-bore—continued.

NATURE.	Charge. — L.G. Powder.	Dia- meter of Cart- ridge Body.	Dia- meter of Ring Gauge.	Length of Cartridge.		Number of Hoops.	Number Packed and Weight of Package.											
							Barrel, Whole.		Ammu- nition Box.		Whole.		Half.		Quarter.			
From		To		Braid.		Worsted.		Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.			
32-pr.	- - - - -	in.	in.	in.	in.	—	—	—	—	—	—	—	—	—	—	—		
				10.75	9.2	—	—	—	—	—	—	—	—	—	—	—	—	
				8.0	8.0	—	—	—	—	—	—	—	—	—	—	—	—	—
				7.5	7.5	—	—	—	—	—	—	—	—	—	—	—	—	—
				6.5	6.5	—	—	—	—	—	—	—	—	—	—	—	—	—
24-pr.	- - - - -	in.	in.	10.5	8.3	—	—	—	—	—	—	—	—	—	—	—		
				5.52	5.52	—	—	—	—	—	—	—	—	—	—	—	—	
				5.4	5.4	—	—	—	—	—	—	—	—	—	—	—	—	
				5.2	5.2	—	—	—	—	—	—	—	—	—	—	—	—	
				5.2	5.2	—	—	—	—	—	—	—	—	—	—	—	—	
18-pr.	- - - - -	in.	in.	9.0	5.75	—	—	—	—	—	—	—	—	—	—			
				5.02	5.02	—	—	—	—	—	—	—	—	—	—	—		
12-pr.	- - - - -	in.	in.	8.6	6.0	—	—	—	—	—	—	—	—	—	—			
				4.39	4.39	—	—	—	—	—	—	—	—	—	—	—		
9-pr.	- - - - -	in.	in.	8.2	4.02	—	—	—	—	—	—	—	—	—	—			
				6.7	4.02	—	—	—	—	—	—	—	—	—	—	—		
				4.9	4.02	—	—	—	—	—	—	—	—	—	—	—		
6-pr.	- - - - -	in.	in.	5.5	3.5	—	—	—	—	—	—	—	—	—	—			
				4.4	3.5	—	—	—	—	—	—	—	—	—	—	—		

Table of Filled Cannon Cartridges.—Smooth-bore—continued.

NATURE.	Charge. — L.G. Powder.	Dia- meter of Car- tridge Body.	Dia- meter of Ring Gauge.	Length of Cartridge.		Number of Hoops.		Number Packed and Weight of Package.													
								Barrel, Whole.				Ammu- nition Box.		Case, Powder, Copper-lined.							
								Braid.		Worsted.		Number.		Weight.		Whole.		Half.		Quarter.	
								From	To			Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.
13-inch mortar	20 0 16 0 9 0	in. 8.35 8.2 7.85	in. — — —	in. 12.75 12.0 7.3	in. — — —	— — —	3 3 1	4 5 10	lb. 115 116 125	2 3 5	lb. 62 70 67	5 6 12	lb. 160 146 158	— — —	— — —	— — —	— — —				
10-inch "	9 8 4 0	6.5 6.0	— —	9.7 5.5	— —	— —	3 1	10 25	131 136	4 12	60 71	12 27	104 158	78 82	— —	— —	— —				
8-inch "	2 0	4.9	—	5.0	—	—	1	48	183	24	72	55	161	81	—	—	—				
6½-inch "	0 7	3.1	—	3.1	—	—	1	220	135	120	77	240	157	84	—	—	—				
4½-inch "	0 5	2.6	—	2.9	—	—	1	260	122	160	76	300	147	82	—	—	—				
10-inch howitzer	7 0 4 0	7.15 6.25	7.76 7.76	6.3 5.3	— —	— —	1 1	13 25	126 136	7 12	72 71	16 27	162 158	78 82	— —	— —	— —				
8-inch "	4 0 3 0	5.75 5.2	6.67 6.67	6.0 5.1	— —	— —	1 1	25 32	136 132	12 18	71 77	27 37	158 161	82 81	— —	— —	— —				
6½-inch "	2 0	4.15	5.1	5.2	—	—	1	48	133	24	72	55	161	81	—	—	—				
4½-inch "	0 8 0 4	2.2 2.2	2.2 2.2	4.6 3.5	— —	— —	1 1	200 350	136 126	140 180	78 70	289 400	167 154	86 83	— —	— —	— —				
32-pr. "	3 0 2 0	4.3 4.3	4.86 4.89	6.8 5.4	— —	— —	2 1	32 48	132 133	18 24	77 72	37 55	161 161	81 81	— —	— —	— —				

Table of Filled Cannon Cartridges.—Smooth-bore—continued.

NATURE.	Charge. — L.G. Powder.	Dia- meter of Car- tridge Body.	Dia- meter of Ring Gauge.	Length of Cartridge.		Number of Hoops.		Number Packed and Weight of Package.									
								Barrel, Whole.	Ammu- nition Box.	Case, Powder, Copper-lined.							
										Whole.		Half.		Quarter.			
										Number.	Weight.	Number.	Weight.				
24-pr. howitzer	lb. oz. 2 8 1 8	in. 4.75 4.2	in. 5.1 5.1	in. 5.6 4.6	— — —	— — —	Braid.	Worsted.	Number.	Weight.	Number.	Weight.	Number.	Weight.			
12-pr.	2 0 1 4 1 0	3.9 3.5 3.4	4.2 4.2 4.2	6.6 5.3 4.5	— — —	— — —	— — —	2 1 1	48 77 94	133 134 134	24 33 42	55 88 110	25 40 50	25 40 50	39 39 39		
68-pr. carronade	5 0	6.3	—	6.3	—	—	—	1	19	130	10	73	22	100	80	—	
42-pr.	3 8	5.7	—	5.3	—	—	—	1	27	131	13	69	32	163	14	79	—
32-pr.	2 11	5.15	—	5.2	—	—	—	1	33	126	18	72	42	164	18	79	—
24-pr.	2 0	4.7	—	4.6	—	—	—	1	43	133	24	72	55	161	25	81	39
18-pr.	1 8	4.1	—	4.4	—	—	—	1	53	124	30	69	74	162	33	83	37
12-pr.	1 0	3.8	—	3.4	—	—	—	1	94	134	42	65	110	162	50	81	39
6-pr.	0 10	3.1	—	3.4	—	—	—	1	130	121	72	69	160	133	72	76	30
Bag, { Rifle L.G. 15 lb. { L.G. P.G.	— — —	— — —	— — —	— — —	— — —	— — —	— — —	— — —	8 155 7	155 140	4 4 4	83 83 83	170 170 170	4 4 4	90 90 90	— — —	

Exercise L.G. or R.L.G. is used for blank charges.

The pentagon, rectangular plain, and various sizes of corrugated brass cases might also be used to contain the S.B. cartridges; but as these cases are for naval purposes, and the S.B. ordnance has practically disappeared from the navy, it has not been thought necessary to give the numbers of cartridges that might be contained in these cases.

TABLE OF FILLED CANNON CARTRIDGES.—B. L. RIFLED ORDONANCE.

Nature,	Description.	Charge.	Length.	Diameter.	Paper Cylinder.	Number Packed and Weight of Package in Pounds.									
						Cases, Powder.					Metal or Brass.				
						No. and Nature of Braid Hoops.	Copper-lined.				Pentagon.		Rectangular.		
							Whole.	Half.	Quarter.	Weight.	Number.	Whole.	Sectional.	Number.	Weight.
							Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.
7-inch	Full, I.	11 ¹ / ₂ L.G.	Inches.	Inches.	Ina.	Narrow	8	141	3	65	—	—	—	—	—
	Blank, I.	10 ¹ / ₂ "	7-03	"	3-25	6	8	133	3	62	—	—	—	—	—
40-pr.	Full, I.	7 "	10 "	"	4-1	2	16	181	5	57	2	29	5	70	174
	Blank, I.	6 "	10-75	4-77	3-25	2	13	135	5	61	—	—	—	17	163
20-pr.	Full, I.	6 "	12-25	"	"	2	26	134	13	60	4	31	11	30	168
	Blank, I.	5-75	10-75	3-77	2-5	2	50	142	{22 ¹ / ₂ {23 ¹ / ₂ {30 ¹ / ₂ {	71 ¹ / ₂ {23 ¹ / ₂ {30 ¹ / ₂ {	9	35	23	53	178
12-pr.	Full, I.	1 ¹ / ₂ "	8 "	3-03	—	4	70	154	{32 ¹ / ₂ {33 ¹ / ₂ {38 ¹ / ₂ {	77 ¹ / ₂ {78 ¹ / ₂ {79 ¹ / ₂ {	13	36	28	72	178
	Blank, II.	1 "	8-25	3-07	—	3	100	150	{44 ¹ / ₂ {45 ¹ / ₂ {	75 ¹ / ₂ {76 ¹ / ₂ {	18	36	46	108	179
12 or 9 pr.	Full, I.	13 oz.	6-25	2-53	—	3	—	—	—	—	—	—	—	—	—
	Blank, I.	10 oz.	6-25	"	—	3	—	—	—	—	—	—	—	—	—

* For 7-inch, 82 cwt.

† For 7-inch, 73 cwt.

‡ With paper covers.

Exercise L.G. or R.L.G. is used for Blank.

B, C, D, E, and F corrugated cases may also be used for packing these cartridges.

TABLE OF FILLED CANNON CARTRIDGES.—R.M.L. ORDNANCE.

Number Packed and Weight of Package in Pounds.																			
Cases, Powder.																			
Nature.	Description.	Charge.	Length.	Diameter.		No. and Description of Hoops.	Copper-lined.						Metal or Brass.						
							Whole.			Quarter.			Pentagon.			Rectangular.			
							Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	
Corrugated.																			
A	B	C	D	E	F														
Number.	Weight.	Number.	Weight.	Number.	Weight.														

12½-inch	Battering, I.	130 P ₂	Inches. 29.75 to 31.25	Ins. 12.0	Ins. 10.4	17 broad	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
----------	---------------	--------------------	---------------------------	--------------	--------------	----------	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Table of Filled Cannon Cartridges.—R.M.L. Ordnance—continued.

Number Packed and Weight of Package in Pounds.																																																																																																																																																																																												
Cases, Powder.																																																																																																																																																																																												
Metal or Brass.																																																																																																																																																																																												
Nature.	Description.	Charge.	Length.	Diameter.	No. and Description of Hoops.	Copper-lined.						Rectangular.																																																																																																																																																																																
						Pentagon.			Corrugated.			Pentagon.			Corrugated.																																																																																																																																																																													
						Whole.		Half.	Quarter.	Whole.	Sec-tional.	Plain.	A		B	C	D	E	F																																																																																																																																																																									
						Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.	Number.	Weight.																																																																																																																																																																							
7-inch	{ Battering, I. { Full, I. { Reduced, I. { Service, I. {	{ 30 "P." { 22 R.L.G. { 14 " { 10 L.G. {	{ 22.5 to 23.5 { 18.5 " 19.3 { 13.5 " 14.3 { 9.25 " 9.75 {	{ Ins. { 6.5 { 6.4 " { " {	{ 12 narrow { 5 " { 3 " { 3 " {	{ 5 { 11 { 11 { 41 {	{ 159 { 148 " { 160 " { 157 " {	{ 72 { 71 " { " { " {	{ 3 { 4 " { " { " {	{ 4 { 150 " { 173 " { 160 " {	{ 180 { 189 " { 190 " { 190 " {	{ 4 { 107 " { 157 " { 188 " {	{ 10 { 109 " { 138 " { 148 " {	{ 13 { 149 " { 192 " { 192 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 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189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 197 " { 197 " {	{ 24 { 24 " { 24 " { 24 " {	{ 13 { 132 " { 182 " { 182 " {	{ 16 { 189 " { 189 " { 189 " {	{ 21 { 197 " { 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N.B.—L.G. powder is used in the U.S. for full charges with R.M.L. garrison guns under 10'.

Exercise L.G. or R.L.G. is used for exercise, or service, charges, and the reduced charges for 7", 8", and 9" R.M.L. guns.

* With paper covers.

SMOOTH-BORE ORDNANCE.

CHARGES, BURSTING,—APPROXIMATE.*

Nature of Shell.	Description of Shell.							Number of Calico and Paper Bags.
	Common.	Naval.	Mortar.	Shrapnel Diaphragm.	Hand Grenades.		Dia-phragm.	
					Sea Service.	Land Service.		
	lb. oz. dr.	lb. oz. dr.	lb. oz. dr.	drs.	oz.	oz.	No.	
13-inch -	—	—	10 15 0	—	—	—	—	
10-inch -	6 12 0	6 5 0	5 4 0	—	—	—	—	
8-inch, or 68-pr.	2 9 0	2 9 0	2 9 0	80	—	—	—	
100-pr. -	—	3 13 0	—	96	—	—	—	
56-pr. -	2 7 0	—	—	70	—	—	—	
42-pr. -	1 12 0	—	—	60	—	—	—	
32-pr. -	1 5 0	1 5 0	—	50	—	—	—	
24-pr., or 5½-inch	1 0 0	—	1 0 0	40	—	—	3	
18-pr. -	0 12 0	—	—	30	—	—	2	
12-pr., or 4¾-inch	0 7 0	—	0 7 0	24	—	—	2	
9-pr. -	—	—	—	18	—	—	1	
6-pr. -	—	—	—	10	5	—	1	
3-pr. -	—	—	—	—	—	3	—	

* All smooth-bore shells are now filled by capacity instead of by weight, and the charges here given, except in the case of shrapnel, are taken from W.O.C. 927, the shells being filled in accordance with W.O.C. No. 3 (new series), paragraph 954; also W.O.C. 884; and Royal Artillery Circular *Memo.* 13th December 1864, paragraph 3; "the shell being tapped with a mallet during the process."

The approximate amount of powder required was determined by an experiment in the Royal Laboratory, in 1865, when 10 shells of each nature were filled, and the quantities given above are slightly in excess of the mean result of this experiment, to give even weights; and "it is assumed that as shells of small and large capacity are supplied in about equal proportions, the powder saved in the one case will suffice to make up the deficiency in the others."—W.O.C. 927.

An allowance must be made for displacement by the fuze.—*See also W.O.C. (new series), §1116.*

Thus the 13-inch mortar shell will take approximately 10 lb. 15 oz. of powder without a fuze and 10 lb. 14 oz. 8 dr. with a fuze. In the case of the shrapnel shell the charge is the minimum sufficient to open them, and is either weighed or measured. For field service the weighed or measured charge is issued in paper and calico bag as above.

LATEST PATTERNS OF PROJECTILES FOR WOOLWICH GUNS.

Calibres.	Common Shell.				Palliser Shell.				Palliser Shot.				Shrapnel Shell.				Case Shot.			
	Changes.	Mark.	Length.	Capacity.	Weight.	Weight.	Capacity.	Length.	Mark.	Changes.	Weight.	Capacity.	Length.	Mark.	Capacity.	Weight.	Changes.	Mark.	No. of Balls.	Weight.
	§				lbs. oz.	lbs. oz.		ins.	lbs. oz.	§	lbs. oz.		ins.	lbs. oz.	lbs. oz.	lbs. oz.	§			
12"-5	-	-	-	-	-	2,877	I.	33-0	11 12	803 4	-	-	-	-	-	-	-	-	8 oz.	-
12" 35 ton	2,557	II.	34-45	40 0	615 8	2,490	II.	31-3	9 14	698 5	-	-	-	I.	33-55	303	2,304	II.	258	246 0
12" 25 "	1,765	I.	30-0	37 12	467 7	1,872	II.	29-2	14 0	600 7	2,263	IV.	28-15	III.	29-05	1 15	2,264	II.	258	246 0
11" -	2,378	I.	34-2	29 12	536 4	2,429	II.	28-3	6 7	532 12	-	-	-	I.	31-8	1 12	2,365	I.	210	900 0
10" -	2,524	II.	30-55	20 4	398 4	1,872	II.	26-3	6 14	398 14	2,107	IV.	25-8	III.	31-13	1 9	2,183	II.	139	143 0
9" -	1,765	V.	26-75	19 0	249 12	1,872	IV.	21-45	5 8	248 7	2,222	V.	20-85	III.	25-35	1 5	2,115	IV.	113	107 0
8" -	1,765	III.	24-17	14 8	180 11	1,872	IV.	19-25	4 8	179 5	2,222	IV.	18-8	III.	22-55	1 0	2,188	II.	75	74 0
7" -	1,765	V.	20-4	8 12	116 12	1,872	III.	16-5	2 8	114 10	2,222	VI.	16-1	IV.	19-0	0 12	2,924	V.	71	69 6
7" double	1,765	III.	27-2	10 12	166 5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

REMARKS.

The following projectiles have been made obsolete:—

- 10" shrapnel, Mark I., § 2420.
 7" shrapnel, Mark I., is broken up when returned to Woolwich.
 12" (25-40m) Palliser shell, Mark I.

- 10" Palliser shell, Mark I.
 7" Palliser (solid) shot, Mark II., is used for practice only.
 9" and 7" cases, Marks I. and II., are broken up.
 12" (I.), 10" (I.), 9" (III.), 8" (I.), 7" (III.) are returned for repair, § 2444.

N.B.—The above weight of projectiles are approximate only, a limit being allowed in manufacture of $\pm 1\frac{1}{2}$ per cent.

LATEST PATTERNS OF PROJECTILES FOR R.M.L. SIEGE AND FIELD GUNS.

Calibres.	Common Shell.					Shrapnel Shell.					Case Shot.				
	§ Changes.	Mark.	Length.	Capacity.	Weight, filled.	§ Changes.	Mark.	Length.	Capacity.	No. of Balls.	Weight, filled.	§ Changes.	Mark.	No. of Balls.	Weight.
64-pr. M.L.	-	IV.	ins. 18'0	lbs. oz. 7 2	lbs. oz. 64 0	2,852	V.	ins. 13'72	9	234	lbs. oz. 67 6	2,925	IV.	50, 8 oz.	49 14½
*80-pr. M.L.	-	I.	19'0	8 13	79 14	2,878	III.	15'13	9	288	78 6				
40-pr. M.L.	-	I.	13'53	2 8	33 1½	2,504	I.	13'53	5	180	39 10	2,479	I.	16½ to lb. 405	38 6
25-pr. M.L.	-	I.	12'85	1 12	24 15½	2,726	I.	11'4	3	65	25 3	2,675	I.	245	24 4
16-pr. M.L.	-	II.	10'0	1 2	16 3	2,898	III.	10	1½	128	17 14½	2,279	I.	176	15 3
9-pr. M.L.	-	IV.	7'93	0 7½	9 1	2,853	VII.	7'93	½	63	9 12½	2,802	IV.	108	9 10½
7-pr. M.L.	-	III.	6'75	0 6½	7 6½	2,744	VI.	6'5	½	42	7 8½	2,280	IV.	70	6 4
7-pr. double	-	IV.	11'25	0 15	12 1½	-	-	-	-	-	-	-	-	-	-
7-pr. star	-	II.	6'85	½ dr.	5 1½	-	-	-	-	-	-	-	-	-	-

Marks I. and II. 16-pr. and 9-pr., and Mark I. 7-pr., shrapnel shell, are obsolete.

N.B.—The above weights of projectiles are approximate only.

* The 80-pr. gun, though not a siege or field gun, is introduced here for the sake of convenience.

LATEST PATTERNS OF PROJECTILES, B.L. GUNS.

Calibres.	Segment Shell.						Common Shell.						Shrapnel Shell.						Case Shot.			
	Changes.	Mark.	Length.	Capacity.	Weight.	No. of Seg-ments.	Changes.	Mark.	Length.	Capacity.	Weight.	Changes.	Mark.	Length.	Capacity.	No. of Balls.	Weight.	Changes.	Mark.	Length.	No. of Balls.	Weight.
7-in. B.L.	405	I. 14.48	ins. 14.48	lb. oz. 3 2	lb. oz. 101 12	112	753* 4214	— II.	ins. 18.55 15.8	lb. oz. 7 10 6 8	lb. oz. 105 10 89 8	— I.	—	ins. —	oz. —	—	lb. oz. —	2,188	IV.	ins. 10.35	70, 8 oz.	69 0
40-pr. B.L.	405	I. 10.62	ins. 10.62	0 13	39 7	72	1,425	II.	ins. 13.52	2 4	40 2	1,807	I.	ins. 12.4	3	103	39 3	2,304	II.	ins. 10.15	35, 8 oz.	31 8
20-pr. B.L.	754	I. 8.1	ins. 8.1	Grains. 700	Empty. 19 10	70	1,342* 1,426†	II. III.	ins. 10.87 10.5	1 2 1 2	21 10 21 10	— —	—	ins. —	—	—	—	2,841	III.	ins. 9.3	239, 16½ to lb.	20 5½
12-pr. B.L.	1,001	I. 6.75	ins. 6.75	550	10 8½	48	2,061	III.	ins. 8.35	0 8	11 4	2,210	II.	ins. 8.41	0½	56	10 11	2,058	IV.	ins. 8.5	132, 16½ to lb.	11 8
9-pr. B.L.	1,001	I. 5.4	ins. 5.4	300	8 3½	42	2,001	III.	ins. 6.30	0 6	8 8½	2,210	II.	ins. 7.15	0½	42	8 11	2,059	III.	ins. 6.85	101, 16½ to lb.	9 0
6-pr. B.L.	754	I. 5.05	ins. 5.05	200	5 7	30	—	—	ins. —	—	—	—	—	ins. —	—	—	—	2,899	III.	ins. 6.1	64, 16½ to lb.	5 9

* For L.S.

† For S.S.

SERVICE FUZES.—SMOOTH-BORE AND RIFLE.

(N.B.—This table refers to L.S. equipment only, except where S.S. is specially referred to.)

SHELL.	Gauge.	Fuzes.		REMARKS.
		Time.	Percussion.	

SMOOTH-BORE.

Mortar, 13", 10", 8" -	Large mortar.	Large mortar.	—	The Diaphragm Shrapnel fuze would do for short ranges, and the small mortar fuze might be employed with common shell at long ranges.
Diaphragm shrapnel (except 100-pr.)	Common	Diaphragm shrapnel.	—	
Common, and 100-pr. shrapnel.	"	Common	Pettman L.S., except 100-pr. Shrapnel.	
Common, 24 and 12 prs. when fired from 5½" and 4½" mortars.	"	Small mortar. Common.	- - -	The common fuze would be used up to 10 seconds. Any of the other Marks of M.L. time-fuzes, also the B.L. time-fuzes could be used, according to range.
Naval, 100-pr., 10", 8", or 68-pr., 32-pr.	G.S.	9 and 20 seconds M.L.	Pettman G.S.-	

RIFLE B.L.

Common, 7", and 40-pr.	G.S.	9 and 20 seconds B.L. -	Pettman G.S. and R.L. II. Pettman G.S. R.L. II. R.L. II. B.L. plain.	
Common, 20-pr., S.S. -	"	"		
Segment, 7", and 40-pr.	"	"		
Shrapnel, 12 and 9 prs.	"	5 and 9 seconds B.L. -		
Segment and common, 20, 12, 9, and 6 prs.	Armstrong F.S.	E. time (S.S. only) for segment shell.		

RIFLE M.L.

Common, 7" and over -	G.S.	In the S.S. the 9 and 20 seconds M.L. may be used with the 7-inch gun, 14 lbs. charge.	Pettman G.S.-	The B.L. fuzes could be used with R.M.L. shell, according to the nature of the shell and the range.
Double, 7" - -	"	In the S.S. the 9 seconds M.L. may be used with the 7-inch gun, 14 lbs. charge.	Pettman G.S.-	
Shrapnel, 7" and over, S.S. only.	"	9 seconds M.L. -	—	
Common, 80 and 64 prs.	"	- - - -	Pettman G.S. and R.L. II.	
Shrapnel, 80 and 64 prs.	"	5 and 9 seconds M.L. -	R.L. II. R.L. II. R.L. II. for 16-pr., I. or II. for 9-pr. and 7-pr.	
Common, 40 and 25 prs.	"	9 and 20 seconds M.L.		
Shrapnel, 40 and 25 prs.	"	5 and 9 seconds M.L. -		
Common and shrapnel, 16, 9, and 7 prs.	"	5 and 9 seconds M.L., II. or III.		
Double, 7-pr. - -	"	9 and 20 seconds M.L., II. or III.	—	
Star, 7-pr. - -	"	5 seconds M.L., II. or III.	—	

N.B.—In substituting any time-fuze for another, care must be taken that the top side hole does not appear above the mouth of the fuze-hole, as the flash of discharge might enter.

PROPORTION per cent. of PROJECTILES and FUZES issued for each nature of Rifled Gun, Garrison Service, Army Equipment, 1876.

NATURE OF GUN.		Projectiles.							Fuzes.*						
		Shell.							Shot.	Percus- sion.		Time.			
										Pettman's G.S.	R.L. II.	5 seconds.	9 seconds.	20 seconds.	
		Common.	Double.	Shrapnel.	Segment.	Palliser.	Palliser.	Case.	Sea Fronts only.	Land Fronts only.	Land Fronts only.	Sea Fronts.	Land Fronts.	Sea Fronts.	Land Fronts.
R.M.L.	12" 5.	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	12" { 35 tons	-	20	-	-	-	77	-	3	20	-	-	-	-	-
	25 "	-	20	-	-	-	42	35	3	20	-	-	-	-	-
	11" -	-	20	-	-	-	77	-	3	20	-	-	-	-	-
	10" -	-	20	-	-	-	42	35	3	20	-	-	-	-	-
	9" -	-	31	-	-	-	32	32	5	31	-	-	-	-	-
	7" -	-	26	5	-	-	32	32	5	31	-	-	-	-	-
R.B.L.	80-pr.	-	60	-	30	-	-	-	10	†60	†60	†	†	†	-
	64 "	-	60	-	30	-	-	-	10	†60	†60	†	†	†	-
R.B.L.	7"	-	60	-	-	30	-	-	10	60	60	-	30	20	20
	40-pr.	-	60	-	-	30	-	-	10	60	60	-	30	20	20

[Issued with Army Circulars, dated June 1873.]

GENERAL INSTRUCTIONS for the GUIDANCE of the ROYAL
ARTILLERY in CHARGE of MAGAZINES or AMMUNITION
STORES.

1. No one will pass the barrier at the entrance of a magazine or ammunition store except in the presence of the Officer, Master-Gunner, or Non-commissioned Officer in local charge of the building, who will be responsible that all persons entering comply with the necessary precautions, and that they have no articles of a combustible nature in their possession.

2. All persons employed in magazines, cartridge stores, and in shell stores when connected with cartridge stores, will, before entering the same, change their own clothes and boots for magazine clothing and slippers. This will be effected in the place appointed for shifting, where the boots and clothing taken off will be deposited.

3. Smoking is strictly prohibited near any magazine or ammunition store, and any soldier entering them with a pipe or lucifer match in his possession will be made a prisoner.

4. Only the hand magazine lantern will be used within the magazine or ammunition stores, and then only in the presence of the person in actual charge.

5. Laboratory operations will not be carried on in any magazine, cartridge, or shell store, or in any of the passages connected therewith, but only in the building, or tent, specially provided for the purpose (*vide* Regulations for Laboratories).

6. Every favourable opportunity will be taken for airing the magazines on the principles given in the memorandum attached. Common thermometers will be issued to all magazines containing 100 barrels and upwards of loose powder.

7. Magazines will never be left open unguarded, and sentries will be particularly attentive to the earliest appearance of a storm, however distant, and upon hearing thunder, or seeing a flash of lightning, they will give the necessary notice, in order that the doors and ventilators may be immediately closed.

8. The floor of a magazine or ammunition store will be kept scrupulously clean and free from loose grains of powder. The passages will be covered with hides, wadmiltits, or hair cloths, when powder in bulk is being moved; these coverings should be frequently lifted and dusted.

9. Barrels, cylinders, and cases will be placed so that the air can circulate freely round them. They should be at least six inches from the masonry of the building.

10. No packing or shifting of cartridges, or issue of powder from cases or barrels will be permitted within the block containing the magazine or cartridge stores. These operations will only be carried on in the laboratory.

11. No friction, detonating, or common tubes, fuzes, quick or slow match, signal lights, rockets, or primers will be kept in any magazine or cartridge store, or admitted within the enclosure of a magazine where

gunpowder alone is stored. Tubes and fuzes may be kept in the shell stores.

12. Small-arm ammunition, which contains its own means of ignition, will not be stowed in the same chamber of a magazine with gunpowder, whether the latter is loose or in filled cartridges.

13. Oiled rags, cotton waste, oakum, or cloths for cleaning, are not to be kept in magazines, ammunition stores, or their passages.

14. All boxes, cases, and barrels placed in magazines or ammunition stores will be labelled, and no empty boxes, cases, or barrels will be allowed to remain in them. Barrels containing powder will never be rolled along the floors of magazines or passages, but will be carefully transported from one place to another.

15. Officers, Master Gunners, and Non-commissioned Officers in charge will at all times be particularly careful with everything in or about the magazines, and will take immediate notice of any irregularity they may observe. They will also be very prompt in reporting any defects or repairs necessary either to the interior or exterior of the buildings.

16. An inventory board, showing the contents of the magazine or ammunition store, will be hung up in the lobby or passage leading thereto.

17. The keys of the magazines and ammunition stores will be labelled, and when not in use deposited in a secure place.

18. A copy of these instructions attached to a board will be hung up on the inside of outer doors and on the wall of the entrance to the magazines. Copies for this purpose, printed on foolscap paper, can be obtained on demand.

19. W.O. Form 939 (Standing Orders for Artillery Magazines, dated Horse Guards, 1st December 1865) has been cancelled.

H. K. STORKS.

[Issued with Army Circular, dated June 1873.]

REGULATIONS to be observed in MAKING-UP CARTRIDGES, FILLING SHELLS, and EXAMINING AMMUNITION in LABORATORIES in ARTILLERY CHARGE.

1. By the term "laboratory" is meant the block of buildings (with the passages and ways leading thereto) in which the examination of all ammunition will take place, cartridges made up, and shells filled. In most works suitable buildings for the purpose have been erected, consisting of a lobby with barrier at the entrance, and filling room for shells or cartridges, with hatches or openings for the admission and delivery of powder or filled cartridges and shells. Where no laboratory building exists a tent will be used.

2. Laboratory operations will be carried on under the superintendence of an officer, who must satisfy himself that the several men, as detailed

in § 3, understand the duties entrusted to them. The presence of an officer will not, however, be necessary at small detached forts or batteries in charge of master gunners where ammunition is made up for the auxiliary artillery.

3. The party for laboratory operations will be detailed as follows:—

Two men as magazine men, to issue powder in barrels from the magazine, and receive and stow cases or cylinders containing made-up cartridges.

Four men for conveying the powder barrels and cases with cartridges or filled shell to and from the laboratory. Two men will be sufficient if only one barrel of powder, or less, be required.

Eight men for the cartridge or shell-filling room, or less, if a small quantity of ammunition is to be made up. These men will be detailed to unhead the barrels, weigh out charges, make up cartridges, or fill shells, as may be required.

Two men will be required at the entrance or receiving hatch, to pass in empty shells.

4. The men engaged in the laboratory will exchange their clothing and boots for laboratory clothing and slippers, in the place provided at the entrance, and will on no account re-pass the barrier, without again changing their clothing.

5. Previous to being told off, the men must be warned to lay aside any knives, pipes, matches, or combustibles they may have about them. Any infringement of this rule will be dealt with as *disobedience of orders*.

6. The operations of filling shells and making-up cartridges will never be carried on at the same time in the same room or tent.

7. The greatest attention will be paid to cleanliness in all parts of the laboratory and ways leading thereto; also in the wagons and barrows used for the conveyance of the powder or ammunition to or from the laboratory. Any loose grains of powder, dust, or grit, will at once be swept up.

8. No barrow, tool, or tackle used outside will be admitted within the barrier at the entrance of the laboratory.

9. Nothing will be kept inside the barrier of the laboratory but the authorised articles for a laboratory, a proportion of clothing, also a supply of zinc cylinders for cartridges, which must be thoroughly examined previous to admission.

10. The shells to be filled will be piled on old shot or stone, outside the entrance to the laboratory or hatch, lettered "For admission of shell," if there be one. The shells will be thoroughly cleaned and brushed externally before being passed into the laboratory—planks being laid down when the heavier shells are filled, in order to save the floor.

11. All shells, previous to filling, will be carefully searched internally, and all loose filings or pieces of lacquer removed.

12. All shells up to the 9-inch inclusive, can be *up-ended* by hand on the blocks, for examination and filling. Heavier shells require the tackle and strap.

13. Made-up cartridges or filled shells will on no account be issued by the same door or hatch through which the loose powder or empty shells are passed in.

14. Powder barrels will be conveyed to the laboratory, and zinc cylinders, containing filled cartridges, to the magazine or cartridge store, in barrows, in order to keep them free from dirt or grit.

15. The floor of the chamber in the laboratory appropriated as a filling room will be covered with hides when in use.

16. Empty powder barrels will be passed out at once, and stored in a clean place ; and in the event of a barrel not being emptied, it will be re-headed and returned to the magazine.

17. Not more than the equivalent to two barrels of powder will be in the laboratory, or in transit between the magazine and laboratory, at the same time.

18. A copy of these instructions attached to a board will be hung up in the entrance to the laboratory. Copies for this purpose, printed on foolscap, can be obtained on demand.

H. K. STORKS.

[Issued with Army Circulars, dated June 1873.]

**REGULATIONS to be observed in the EMPLOYMENT of LAMPS for
LIGHTING MAGAZINES, AMMUNITION STORES, LABORATORIES,
and their PASSAGES.**

1. On no account will any but the authorised lamps be used for the purpose of lighting magazines, ammunition stores, laboratories, and their passages.

2. Such lamps only will be lighted from time to time as the officer commanding may direct.

3. A magazine copper lantern will be used for the inspection of the ammunition stores and underground passages.

4. One or more men, as may be required, will be specially detailed as "lampmen" *for each work*, to attend to all the lighting arrangements and stores connected therewith.

5. As all passage and wall lamps required for lighting the ammunition stores can be placed in position from the "light" passages, the lampmen will on no account pass beyond the junction of the "light" passages with the general passages.

6. When it is impossible to clean the glass of the light recess from the lamp passage, such glass must be cleaned by one of the magazine men from the inside. This in some cases may necessitate the unscrewing and removing of the frame ; if so, care will be taken that it is properly replaced. This operation should be effected in the presence of the Officer or Non-commissioned Officer in charge.

7. All lamps, when not in use, will be kept in the lamp room.

8. A copy of these instructions attached to a board will be hung up in each lamp room. Copies for this purpose, printed on foolscap paper, can be obtained on demand.

9. Should any special instructions be required in any particular work for the guidance of the lampmen in the management of any peculiar lamp recesses they should be added in manuscript.

H. K. STORKS.

**INSTRUCTIONS for PROOF of TUBES, PRIMERS, DETONATORS
of FUZES, &c., to accompany the APPARATUS for PROOF of
TUBES, PRIMERS, and DETONATORS of FUZES, Mark II.**

1. The apparatus consists of two stands with the necessary vents, anvils, and weights for proof of all descriptions of tubes, primers, and detonators for fuzes.

Proof of Tubes and Primers.

2. The stand for proof of tubes and primers is a cast-iron table fitted with two vents, one for proof of "tubes, friction, copper," and one for proof of "tubes, friction, quill," in connexion with which is a pin friction tube" and a "guide plate," the same as fitted on guns for naval service; the stand is also fitted for a special vent for proof of primers for shrapnel shell. Two iron spanners for fixing and unfixing vents, &c., are furnished with the stand.

3. For proof of "tubes, friction, copper," a brass vent A in two parts, upper and lower, and a receiver A for a powder puff, are screwed upon the proper vent provided for that purpose: the upper part alone with the receiver represents a vent of 14 inches, with a clear space of about half an inch to the top of the powder puff; the addition of the lower part represents a vent of 30 inches. All long tubes are to be tested in the 30-inch vent. Tubes for general service in the 14-inch vent.

4. For proof of "tubes, friction, quill," a brass vent B in two parts, and a receiver B for a powder puff, are provided and fitted on the proper vent, as described for the vent A for copper friction tubes.

5. For proof of "tubes, friction, copper, 7-pr. M.L. gun," a brass vent with receiver for a powder puff C 3 inches long is provided; it is to be screwed on the vent for quill friction tubes in place of the brass vent B.

6. For proof of "primers, vent-piece," a special brass vent D, and a receiver D for a powder puff four inches long, are provided; this vent is also screwed on the vent for quill friction tubes; the primer is to be inserted in the horizontal end of the vent, and the receiver then screwed on. The distance between the end of the primer and the puff to be four inches. The primer is to be fired by means of an ordinary friction or other tube, placed in the vertical portion of the vent. Tubes known to be good should be used for this purpose.

7. For proof of "primers, brass, shrapnel shell," a special brass vent with receiver E 30 inches long is provided; the upper end of this vent is fitted internally to receive the primer, it is passed up and screwed through the top of the stand, and through a steel boss which is fixed on the top of the stand. The boss is screwed and fitted to receive a brass cap for covering and enclosing the top of the vent when fitted with the primer; the brass cap has a small hole bored through the side, as a means of communication for a piece of quick match for firing the primer. About 2 drams of loose powder is to be placed in the receiver at the bottom of the vent.

8. The powder puff contains 2 drams of F.G. powder, and is made with 2 thicknesses of serge. A special puff of 1 thickness of serge is used for the tubes for 7-pr. R.M.L. gun, and a puff of 1 thickness of

serge and 1 of waterproof material is used for the copper friction tube for waterproof cartridges.

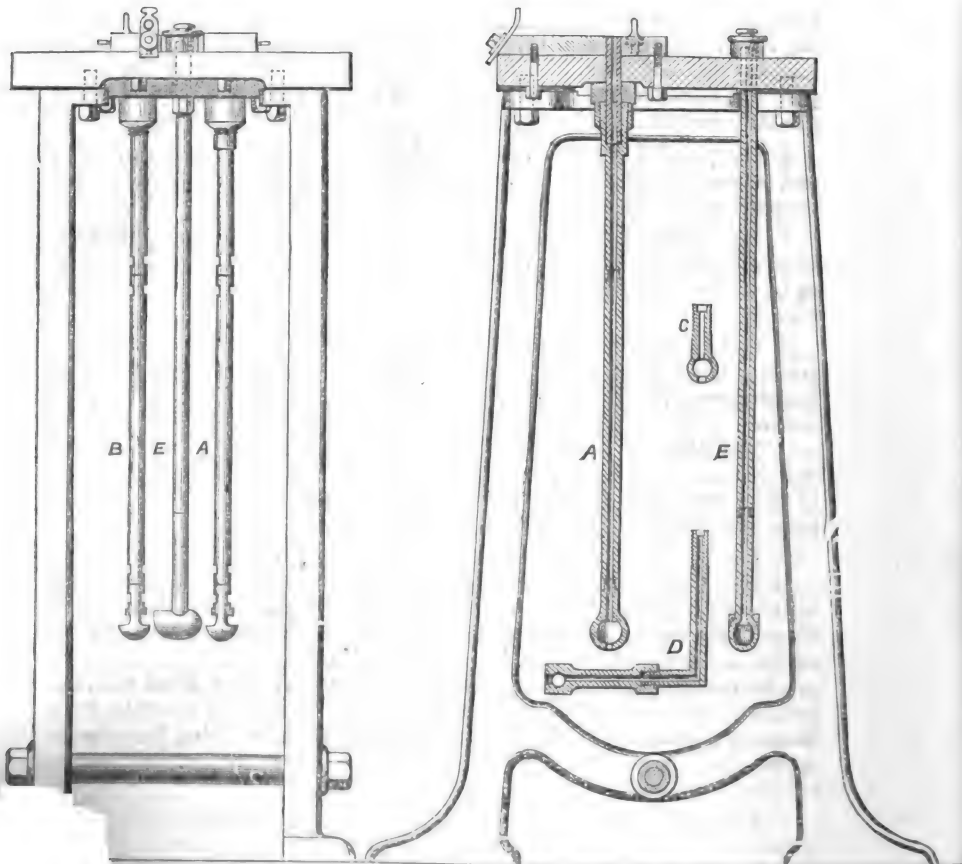
9. A failure of 3 per cent. in tubes that have never been issued for service, or of 5 per cent. of tubes that have been issued and returned, will warrant *suspicion* that the tubes are unserviceable.

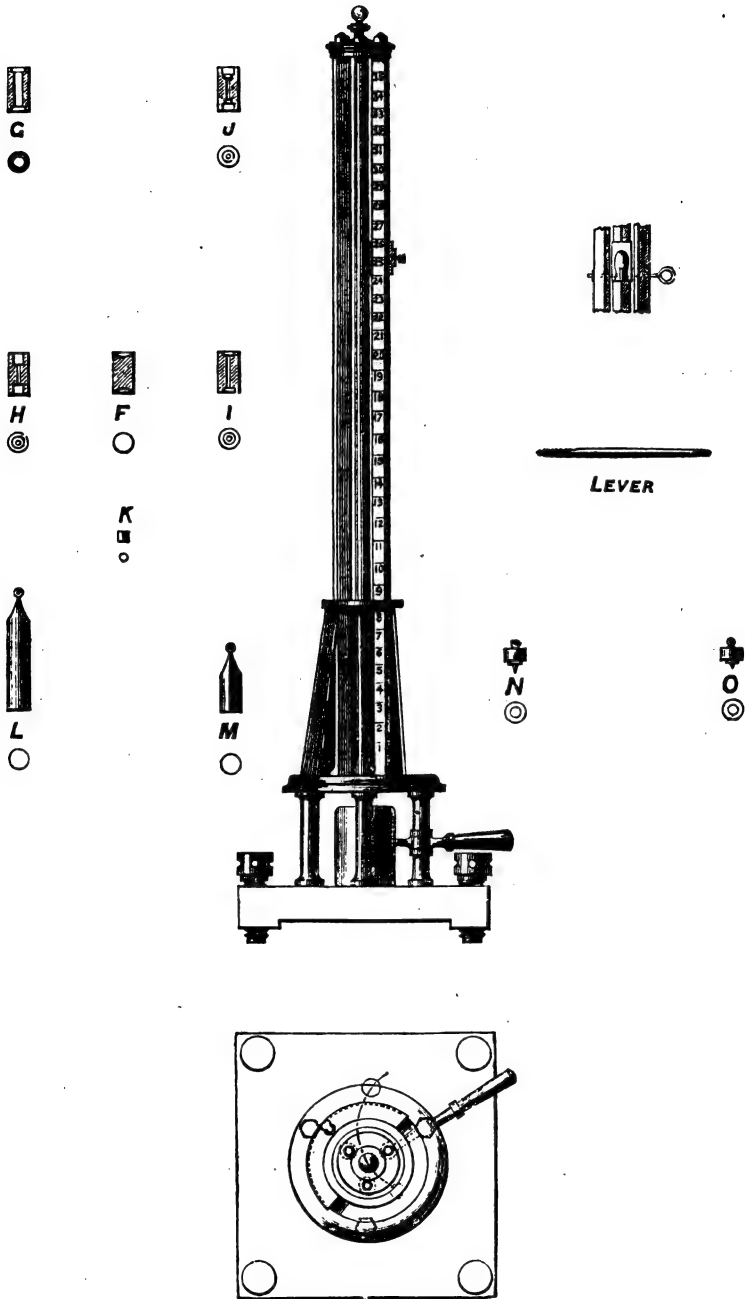
10. Cylinders of tubes thus suspected being set aside, one or more will be tested by firing every tube in them.

11. No report of the unserviceability of friction tubes is to be made, or per-centage of failures deduced, upon a less trial than 100 tubes.

12. Inspectors of warlike stores will keep up their knowledge of the condition of the tubes in their district by obtaining from Commanding Officers of Artillery sample cylinders of tubes manufactured at different dates. Should the tubes be otherwise packed than in the tin cylinders closed with a soldered tin band, the inspecting officer will use his judgment as to the proportion to be tested. If these samples are unsatisfactory, more cylinders must be opened in order to form a judgment upon their condition.

13. Tubes, quill, friction, *without* loops, should be returned (if in good order) as repairable (to tubes with loops).





Proof of Detonators of Fuzes.

14. The stand for proof of detonators of fuzes consists of a cast iron base plate, fitted on the top with 3 wrought iron pillars, carrying a brass plate, on which is erected 3 steel guide bars of such a height as to admit of a weight, placed within the bars, being dropped a clear distance of 25 inches on to the top of a detonator on an anvil placed on an anvil bed beneath the guide bars : one of the guide bars is graduated in inches, and is fitted with a suspender or sliding bracket with fixing screw for carrying the weights; the weights are attached to the suspender by a brass pin; when all is prepared for releasing the weight, the pin is to be drawn out with a *sharp* pull, so as to allow the weight to drop freely. The anvil bed of wrought iron is attached to one of the wrought iron pillars by a handle, which acts as a lever with the pillar as a pivot, so as to allow the anvil bed to be moved from the centre of the stand whilst the required weight and anvil are being inserted, or removed from within the guide bars at the bottom.

To protect the operator from the effect of the explosion of the detonator, a shield of sheet brass, in the form of a half frustum of a cone, is fitted on the brass plate so as to revolve round the guide bars, the open side of the shield being brought next the operator when placing the detonator, weight, and anvil, and the shield reversed before the weight is released.

This stand is intended to rest on the top of the stand for proof of tubes when in use, and, in order to adjust it perpendicularly, the base plate is fitted with four adjusting screws; a "lever, steel, for adjusting screws," is provided for this purpose. Before using the stand care should be taken that the fall is perfectly true; this may be ascertained by hanging any small weight or plummet by a thread to the pin through the eyes of the suspender.

15. The detonators are to be proved as described in the following paragraphs, care being taken in each operation to insert the proper anvils and weights, as undermentioned, viz. :—

- F. Anvil, steel, for detonating balls of Pettman fuzes.
- G. Anvil, steel, for steady plugs of Pettman fuzes.
- H. Anvil, steel, for detonators of B.L. wood time fuzes.
- I. Anvil, steel, for detonators of fuzes, percussion, R.L., Mark I., and B.L. plain.
- J. Anvil, steel, for detonators of fuzes, percussion, R.L., Mark II.
- K. Plug, steel, for detonators of B.L. wood time fuzes.
- L. Weight, steel, 18-oz.
- M. Weight, steel, 7½-oz.
- N. Weight, brass, and steel-pointed, 1-oz., for fuzes, percussion, R.L., Mark I., and B.L. plain.
- O. Weight, brass, and steel-pointed, 1-oz., for fuzes, percussion, R.L., Mark II.

16. The detonating balls of Pettman general service percussion fuzes are to be proved by allowing the 18-oz. steel weight L to fall on them through a height of 25 inches. Care must be taken that the face of the anvil F on which the ball rests, and the striking face of the weight, are cleaned between each explosion.

17. The detonating balls of Pettman land service percussion fuzes are to be proved with the 18-oz. weight L falling through a height of 22 inches, the faces of the anvil F and the weight being cleaned between each explosion.

18. The steady plugs of Pettman general service percussion fuzes are to be proved by allowing the 18-oz. weight L to fall through 25 inches on to the brass ball of the fuze placed over the ring of composition in the steady plug, on the anvil G.

19. The brass detonators of Boxer breech-loading wood time fuzes are to be removed from the fuzes, the brass plug unscrewed from the top, and then (without removing the suspending wire) placed on the anvil H and proved by allowing the $7\frac{1}{2}$ -oz. weight M to fall through a distance of 22 inches. To enable the blow to be communicated to the detonator, a small steel plug K is provided, which is to be placed upon the hammer of the detonator.

20. The detonators of the B.L. percussion fuzes, plain, and the R.L. percussion fuzes, are to be proved by placing the pellets containing them on an anvil and allowing a pointed weight of 1 oz. to fall on them through a distance of 10 inches. The powder in the pellets is not to be removed. There are two anvils and two weights provided for the proof of these detonators, the anvil I and the weight N for R.L. fuzes of Mark I. and for B.L. plain fuzes, and the anvil J and the weight O, with a shorter needle point, for R.L. fuzes of Mark II.

21. The following table gives the details of the different proofs :—

		Weight.	Height.
Detonating ball {	Pettman G.S. fuzes,	18 oz.	25 inches.
	" L.S. "	18 "	22 "
Steady plug -	" G.S. "	18 "	25 "
Detonator B.L. or R.L. percussion fuzes		1 "	10 "
Detonator Boxer B.L. wood time fuzes		$7\frac{1}{2}$ "	22 "

22. If a detonator fails the first time, it should be tried a second and third time ; but the fact of a detonator requiring more than one blow should excite suspicion.

23. Detonators of fuzes should not be condemned on the trial of a less number than 3 per cent. ; a failure of more than 5 per cent. of this number is sufficient to condemn them. Care should be taken in reporting the result of the examination to quote all the marks on the fuzes and the cylinders, and to state if the latter have ever been opened. Rule 12 for tubes should be applied also for fuzes.

Proof of Wood Time Fuzes for B.L. and M.L. Ordnance.

24. Judgment of the state of these fuzes will be formed from the average time of burning of not less than 20 ; and selection for proof should be taken, at the rate of about 2 per cent., from those manufactured about the same date.

25. In proving B.L. fuzes, the detonators will be removed, and quick match inserted, by which the fuzes can be ignited. (For proof of detonators, see above.)

26. Fuzes will be condemned if their time of burning is not within the following limits, viz. :—

The 5 secs. fuze should not reach 5.5 secs. nor burn less than 4.8 secs.

9 "	"	"	11.0 "	"	"	9.7 "
20 "	"	"	22.0 "	"	"	19.4 "

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